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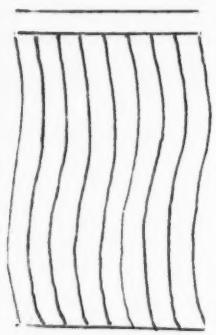
TILLAGE OF THE OLD MANORIAL LANDS.

By Canon ISAAC TAYLOR.

JOURNEYING by rail through the great pasture lands of England, especially in the midland and northern counties, the traveller can hardly help observing that most of the grass land lies in parallel ridges or undulations tolerably uniform in size, not unlike the swell on the sea after a storm. The sensation which riding across them produces is much the same as that of tossing in a small boat. If these ridges be observed more narrowly, it will be found that they are usually a little more than two hundred yards in length, and of uniform breadth, usually either two perches or one. In each field they are all of uniform height, but in some fields they are much higher than in others, the height, measured from the bottom of the hollow to the top of the ridge, varying from a few inches to two or even three feet. These ridges hardly ever run in a straight line, but are gently and regularly curved in the shape of a reversed S, the curve, as you proceed from the centre of a ridge towards either end, invariably inclining to the left hand. The accompanying plan represents the ridges in a field which contains four acres. This field, which is old pasture land, is twice as long as it is broad, and contains ten ridges, locally called "lands" or "rigs," but which are styled sellions in ancient documents. The "lands" or "rigs" are each a furlong or 220 yards in length, and two perches or eleven yards in breadth, each of them thus containing as nearly as possible half-an-acre. If you ask a passing labourer why the field is thus ridged, he will probably tell you that he "doan't 'xactly knoaw," but "s'poses it wur laid down in rig, sometime back, to let t'waater rin off." This explanation, however, is clearly inadequate, for after heavy rain it will be seen that the water does not run off, but gathers in separate pools at the lower end of each of the hollows between the rigs. Further examination will show that this is due to a high bank of earth, locally called a balk, which runs at right angles to the rigs at each end of the field and overtops them, being occasionally as much as two or three, or even four feet high, thus effectually damming up the water which has run down the hollows between the rigs. Clearly the drainage hypothesis must be rejected. The rigs are also an inconvenience when the field is meadowed, often making the use of a machine mower difficult or impossible; while they do not improve the pasture, the crop being too light on the summit of the ridges, and rank and coarse between them. Moreover, the "sometime back" at which the labourer supposes the ridges to have been made must have been a very long time ago, since the hedges which bound the field laterally, and which bear hedge-row timber often of great age, follow the curve of the rigs, instead of being straight as would naturally be the case, and actually is the case with the hedges at the end of the rigs. The uniformity in the length and breadth of the rigs, and their curious curvature, which bends invariably to the left, has also to be taken into account in framing a satisfactory explanation.

This explanation is suggested by the fact that the "lands" are usually 220 yards, or exactly a furlong, in length. Now a furlong, as the etymologists tell us, is a contracted form of the old English word "furrow-long," an indication that these rigs must be due to ancient tillage. But why are the rigs of uniform breadth—usually 11 yards or 5½, and why do they each contain either a half acre in the first case, or a quarter of an acre in the second? This is explained by the fact that an acre is the amount that a ploughman can most conveniently plough in one day, as is also indicated by the word *morgen*, the German equivalent of the English acre, which evidently denotes the "morning's" work. In some southern counties the ploughman designates his day's work as his "journey," the Norman-French *journée*, the equivalent of the German *morgen*. The breadth of the rig is either one rod, as it is called, or else two. As our "tables" tell us, 5½ yards make one rod, pole, or perch. The word "perch" means the same as rod and pole. It is from the Latin *pertica*, "a pole or measuring rod," and now signifies either a measure of 5½ yards, or the rod placed in a bird-cage for the bird to sit on; whence, as a later formation, we get the verb "to perch." But why should the perch be a measure of precisely 5½ yards? Rods, poles, and perches may be cut of any length. The length of the measuring "rod" must be determined by some cause, and the reason is not far to seek. In the old English land tenure, the usual holding of each peasant was called an oxgang, being the amount of land due to the labour of one ox during either the autumn or spring tillage. We know that the use of horses for ploughing is of comparatively recent introduction. Oxen are driven, not, like horses, with a whip, but with an ox-goad, a long rod shod with iron, with the sharp point of which the oxen were pricked to hasten their pace. Now the most convenient length of the ox-goad, so as to enable the ploughman, as he holds the plough-stilts, to reach his oxen, is 16½ feet, the conventional length of the rod, pole, or perch. We now see how the ox-goad came to be used as a land measure. The ploughman laid his ox-goad on the ground at right angles to his first furrow, as a convenient way of measuring the breadth of the "land" which he had to till. At the

present time, when ox-goads are no longer at hand as measuring rods, the ploughman "steps it," and sticks a switch in the ground to mark the breadth of the "land" to be ploughed. There are two other causes which concurred in making the pole of 5½ yards the most convenient breadth for the "lands." The first is that a plough cannot be turned in less than four yards, and hence this must be the minimum breadth of a "land," a little more being an advantage. The other reason is that corn was sown, not with a drill, as it is now, but broadcast. The sower walked along the "land," keeping to the same furrow as a guide, and casting the seed corn alternately to the left and right. I am told that a tall strong man, sowing wheat, is able, at the outside, to cast four yards to his left, while the "off-cast," as it is called, that is the back-hand throw to the right, is three yards at the outside. He can, therefore, cover an extreme breadth of seven yards. But with lighter grain, such as barley, and more especially with oats, the "double cast" is not more than six yards, and with a man of ordinary stature and strength the cast is still less. Hence the breadth of one perch for a "land" is convenient for sowing. If it were broader, only tall men sowing the heavier kinds of grain could cover it. The length of the furrow, the "furrow-long" or furlong, was also determined, like other weights and measures, not arbitrarily, but by natural causes. A furlong, 220 yards or one-eighth of a mile, is as much as a team of oxen can conveniently plough without stopping to rest and take breath. It is true that much longer furrows are now drawn, not only because ploughs are lighter and better made, but because horses, which are now used instead of oxen, do not require to rest so frequently.

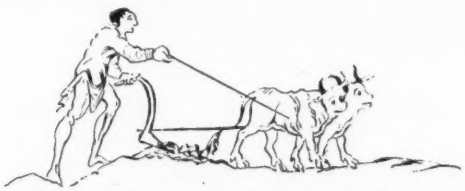


The accompanying plan represents the S-shaped ridges in a field which contains four acres.

We have next to account for the high mounds of earth —balks, as they are called—which are found at either end of the rigs. When a furrow is completed, the ploughman takes the occasion, while the cattle halt, to scrape off the soil adhering to the ploughshare and the coulter. On each halt a pound or two of earth will be scraped off, and in the course of centuries, as the team always rested precisely at the same spot, little by little these great banks, sometimes three or four feet high, and a yard or two in breadth, must have been formed by the slow accumulation of the scrapings from the ploughshare, and when at length the old tillage land was put down to grass the balks were left, often seriously interfering with the drainage of the field. I have noticed cases where the water, after heavy rain followed by a frost, has been so dammed up by the balks, as to accumulate in such long narrow ponds between the rigs that, when covered by a crust of ice, they are used by the village boys for sliding.

The last point to be explained is the uniform curvature of the "lands." This is due to the fact that oxen and not horses were employed, and, the labour of oxen being less efficient than that of horses, large teams normally consisting of as many as eight oxen were yoked to the plough, though when the soil was light four might suffice; thus accounting for the fact occasionally mentioned in Domesday that in certain small manors the villans possessed only "half a plough," which evidently denotes a plough drawn by four oxen. Two oxen, as shown in the cut, seem rarely to have been used. The oxen, whether eight, six, or four, were yoked two and two. It is manifest that in ploughing with eight or even four oxen the team would extend over a considerable space, and the foremost oxen could not be directed by the ploughman with his goad. Hence, as we see in old drawings, a man was employed to guide the leading yoke of oxen, walking on the near side. When the plough came to the end of the furrow, he would turn the team by putting his hand to the heads of the leaders. As it is easier to pull than to push, and as he would naturally pull with his right hand rather than with his left, it is evident that as the oxen were preparing to turn, the furrow would deviate slightly from a straight line, the deviation being always to the left, and amounting possibly to an inch or so at each turn. In the course of years these deviations would accumulate, so as ultimately to curve the end of the rig considerably to the left. These accumulated deviations frequently amount to four or six yards, and occasionally, where the height of the rigs show long continued tillage, to considerably more, sometimes as much as thirty or forty yards. This deviation would take place at both ends of the rig, thus causing them to assume the characteristic shape of an S reversed.

These rigs are only conspicuous in old pastures. In land still under tillage they have been usually effaced by the cross ploughing which is now adopted. But in dry seasons, for a week or two before harvest, they can occasionally be detected, even when the soil is apparently level, owing to the fact of the straw growing more luxuriantly, and therefore maturing a little later along the line of the old depressions than along the summit of the rigs. The cornfield in such cases appears to be striped in alternate bands of green and yellow, conforming to the direction and the breadth of the old rigs.



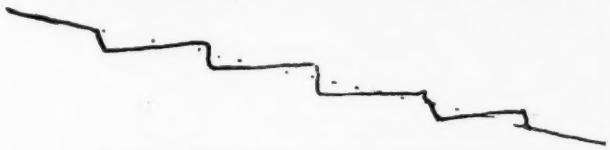
ANGLO-SAXON TWO-OXEN PLOUGH TEAM.
(*From the Harleian MS.*)

But in most instances the rigs have been preserved, owing to the land being in grass. The present pastures usually answer to the old arable, and the present arable to the old pastures. The reason of this is not difficult to explain. Domesday Book contains abundant evidence that, at the time when it was compiled, the population was sparse and land superabundant. Only a small portion was in tillage, as there were no large towns to be supplied, and no means of conveying to distant markets the superfluous produce which was not required for the wants of the cultivators. Thus, in my own parish the population in the 11th century was barely one-fourth of what it is at present, and only about one-third was tilled, instead of more than two-thirds as is now the case. Hence, only the best soils were selected for tillage, all the poorer lands being left in grass. But in our own days, with improved methods of farming, it is found more profitable to till the poorer soils, and to keep the best under permanent pasture. The change probably commenced at the time of the Black Death, when the agricultural population was greatly diminished, and was accelerated in the Tudor period, when the production of wool had become a chief source of

wealth. But whatever may be the cause, it can be proved that the Domesday arable is now mostly in grass, and the Domesday pastures are now in tillage, and hence the rigs which are the signs of ancient tillage, have to a great extent been preserved.

Where the slope is gentle the rigs usually run downwards. But where the slope is at all steep we find a series of conspicuous parallel terraces, locally called reeans or iinces, which, like the rig, are manifestly the results of ancient tillage. It would be undesirable to plough up and down hill, because a team which could draw the plough on level ground would be unequal to the labour of drawing it up hill, while if the rigs had been drawn down a steep declivity the soil would be swept away along the furrows by the rain. Hence the plough went horizontally along the face of the hill, and the sod being turned always in same direction, downwards, these terraces have been gradually excavated. The cut gives a section of some of them, the dotted line marking the original contour.

It has been said that the plough was normally drawn by eight oxen. The number seems large, but the oxen were small and weak, and owing to the difficulty of feeding them in winter were probably half starved. That eight oxen were reckoned to each plough, is proved by the fact that the carucate or ploughland, which represented, for purposes of taxation, the annual tillage of each plough, was divided into eight bovates or oxgangs, each oxgang representing the labour of one ox. An oxgate, for the



SLOPE OF HILL SHOWING LINCES OR TERRACES.

pasturage of the ox, went with the oxgang. But few, if any, of the peasants possessed so many as eight oxen, the usual number being two. In Domesday we continually find entries that in a certain manor there were four villans with one plough, or twelve villans with three ploughs. The tillage was performed by co-operative labour, each of the villans contributing one, two, or three oxen to the plough, and having a right to a proportional part of the produce. It will, however, be noticed that in the plan of the "lands" in a "culture" given above, there are ten "lands" instead of the eight we should expect. The reason seems to be that the parson had the right to his "tithe" or tenth of the produce. This might be arranged in one of two ways. He might either take every tenth sheaf, or in each "culture," as it was called, one "land" or rig might be tilled by the co-operative plough for the parson, who took the produce in satisfaction of his due. Moreover, the ploughman who held the stilts was not paid in money, which was scarce, but by the produce of another "land." Hence, when there were ten "lands" in a culture the produce of one went to the parson, another to the ploughman, while the other eight went severally to the owners of the eight oxen which had drawn the plough.

But when, as was usually found more convenient, the parson instead of taking for his tithe the produce of every tenth "land," took instead every tenth sheaf, there was no necessity for having ten lands in the culture, and the number was reduced to nine. We still possess a survival of the practice of paying the ploughman by the produce of the ninth land, in the fact that it is still usual in many parts of England to consider one culture or one "great land," as it is called, as being made up of nine "small lands," these small lands being the rigs, originally a perch or 5½ yards in width, though now usually not quite so wide, because horses are employed in tillage instead of oxen.

The other village officials, notably the pounder, whose business it was to impound stray cattle, were also paid for their services either in land or in kind. The Boldon Book, which is a register of the tenures and services in the Bishopric of Durham, compiled by order of Bishop Pudsey, in 1183, affords evidence of such tenures. We find that in each manor the villans hold equal amounts, either one or two oxgangs, as the case may be, while the pounder has assigned to him a certain number of acres, from four to twelve, and also has a right to one thrave of corn from each plough, a thrave consisting of either twelve or twenty-four sheaves, according to local custom. That there was no market for the pounder's corn is shown by his having to pay his dues to the bishop in hens and eggs.

The carpenter usually holds from four to twelve acres for making the ploughs and harrows for the lord's ploughs, being doubtless paid by thraves for similar services to the villans. The smith's craft was more important, as he usually holds from eight to sixteen acres for making the ironwork for the ploughs. The beekeeper has "six acres for his service in beekeeping." The mason holds sixty acres, the marble cutter thirty acres, the bailiff usually twenty-four; and the priest, in addition to his tithes, holds from twenty-four to forty acres. These holdings were not in severalty, but consisted in the right to the produce of so many acre or half-acre strips in the common field which was in tillage in any particular year, and which at the end of the year went back to fallow, and was pastured in common by the tenants of the manor.

A SIMPLE EXPLANATION OF CLERK MAXWELL'S THEORY OF ELECTRICITY.

BY R. CAMPER DAY, B.A.Oxon.

II.

IN the previous paper it was explained that, according to Maxwell's theory, a magnetic line of force, whether proceeding from a magnet or surrounding an electric current, may be supposed to consist of a row of vortices rotating about the line as an axis, so that a line of force in a given field indicates the line of least pressure. It was also shown that some such mechanical arrangement as our hypothetical aggregation of vortices serves to account for the dynamical action of magnets upon one another and upon currents. In the present paper it is proposed to deal with currents themselves, and endeavour to find some answer to the question, "What is a current of electricity?" In order that the answer to this question may be understood, we must further consider the little particles which we have imagined to be interposed between the vortices. The circumferences of these particles are as thoroughly geared to the circumferences of the vortices as if they were cogwheels. The vortices and the particles are in close rolling contact with one another. Whenever a vortex rotates, therefore, it must cause all the contiguous particles to rotate in the opposite direction without the slightest slipping of the touching surfaces.

Now the vortices themselves, although they rotate freely on any axis, and although they may be deformed or squeezed out of shape by pressure, are supposed to remain in their relative places. With the particles, however, the the case is not quite the same, and here we come to the

fundamental difference between conductors and dielectrics. In a dielectric the particles contained in a given molecule of the substance are unable to move out of that molecule into another; while in a conductor there is nothing to prevent their so moving. In fact, when a current of electricity is passing along a wire, our theory supposes that throughout the entire length of the circuit the particles are moving steadily along. Their motion being impeded by friction, heat is generated in the wire and energy is dissipated, but they move from one molecule to another, and their motion constitutes the electric current.

In order that the movement of particles constituting a current in a wire may be thoroughly understood, let us look for a moment at Fig. 5. AA represents one surface of the wire, and BB the other surface. Interposed between them is a chain of vortices and particles. We will suppose that a current is passing along the wire towards the right. If we consider the particles in the centre of the wire, and suppose them to be moving towards the right, it is evident that they must cause the adjacent vortices c and d to rotate in opposite directions, as indicated by the curved arrows. If b were at rest and rigid the rotation of c would cause the particles between c and b to move towards the left. But as by hypothesis there is a steady current towards the right, we must suppose b to be rotating in the same direction as c; and as there is no slipping of the surfaces, we must also suppose b to rotate much faster than c. Similarly a must be supposed to rotate much faster than b. The vortices and particles outside the wire will rotate with a velocity depending on that of a. In Fig. 1 the line of particles between A and B is supposed to be a current of electricity moving in the direction of the arrows, and the direction of rotation of each vortex in the surrounding field is indicated by arrow-heads.

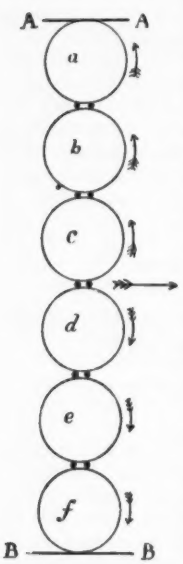


FIG. 5.—A CURRENT IN A WIRE.

Referring back to Fig. 4, let us suppose that no current is flowing in the wire C, and that the wire is pushed by some external force towards w. We have already seen that if there were an ascending current in C, the electro-magnetic forces would tend to move the wire towards w, while a descending current would tend to move it towards e; and we know that when a conductor moves across magnetic lines of force a current is generated in it. If then we push the wire towards w, will the resulting current in the wire be an ascending or descending current? If it is the former it will evidently help us to move the wire in the desired direction; if the latter, it will as evidently oppose the motion of the wire. When we begin to push C towards w, the result is that we squeeze together the lines of force in front of C and elongate them, just as we might elongate so many elastic strings by pressing a lead pencil against them. The pressure exerted by the wire, therefore, tends to lengthen the axes of the vortices and to reduce their oblateness, or, in other words, to increase their polar and diminish their equatorial diameter. But, other things being equal, the velocity of rotation of a vortex depends on the length of its equatorial diameter. The more oblate it becomes, the more the moment of inertia about the axis is increased, and the more the angular velocity is diminished. It is clear, therefore, that when we push C towards w we thereby increase the velocity of the rotation of the vortices between C and w; and similarly it may be shown that we reduce the velocity of those between C and e. We have C, therefore, between two sets of vortices rotating with different velocities. The result is a current in C, whose direction will be that of the eastern portion of each of the vortices between C and w; or, in other words, there is a *descending* current. But we have already seen that a descending current would tend to move C towards e. Our theory, then, harmonizes strictly with Lenz's well-known law, that "induced electro-magnetic currents have such a direction that their reaction tends to stop the motion which produces them."

From Figs. 6 and 7 the reader will be able to obtain an explanation of the effect of neighbouring currents upon one another. Let AA be one wire, and BB another, and first let us suppose that they convey currents in opposite directions. All the vortices between the wires will be rotated in the same direction by both currents, and their velocity will, therefore, be much greater than that of the vortices in the outside regions marked C and C′, and the wires will consequently be pushed apart. An inspection of Fig. 7 will show that when the currents are in the same direction the opposite effect will be produced.

Before we proceed to consider how it is that a current

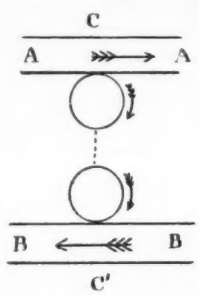


FIG. 6.

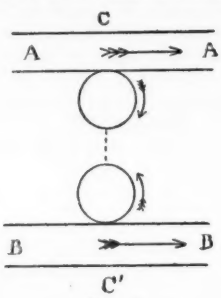


FIG. 7.

FIGS. 6 AND 7.—CURRENTS IN PARALLEL WIRES.

suddenly started in a wire causes a momentary induced current in the opposite direction in a neighbouring and parallel wire, we must look at the electrical particles from a new point of view. They correspond to what are known as "idle wheels" in machinery. In mechanism, when two wheels are intended to revolve in the same direction, a wheel is placed between them so as to be in gear with both, and this wheel is called an "idle wheel." If the second wheel or "follower" have nothing to retard it but its own inertia, then when the "driving" wheel is first started, the idle wheel will not only rotate, but will experience a motion of translation. This motion of translation, however, will only last until the follower has acquired the same velocity as the driver, and the centre of the idle wheel will then cease to move. Bearing this in mind, let us examine Fig. 8, which represents two wires, AA and BB, in the former of which we will suppose a current to be suddenly started in the direction of the arrow. The current will instantly cause all the vortices in the dielectric, from a to m, to rotate in the direction of the curved arrows. But when we come to the wire BB, we may look upon the vortices m and n, the latter of which is inside the wire, as a driver and follower. Some little fraction of time must elapse before n acquires the same angular velocity as m, and during this interval the particles in the wire will move off towards the left, and there will be a momentary current. As soon as the vortices inside the wire have got into full swing the current will cease.

We have now a current flowing steadily in AA, but in BB there is no current, although its vortices are rotating at full speed. If at this stage we cut off the current in AA, the vortices in the dielectric come to rest much more rapidly than those in BB. The latter expend their energy in producing a momentary induced current in BB, the direction of which, as a little consideration will show, must necessarily be the same as that of the original current in AA. The point to be insisted on is that the vortices are supposed to have mass, so that a distinct interval of time must elapse before they acquire their full velocity, and when the force which rotates them is suddenly removed there follows a distinct interval of time during which they expend their energy in doing work. When a current is started in a wire it is opposed by what seems to be a contrary electro-motive force, called into action by the current itself. According to the vortex theory, this opposing force, or self-induction, is due to the "mass" of the vortices; it is only an opposing force in the same sense as the reaction of a body against acceleration.

The application of Maxwell's theory to static electricity would require more space for its complete explanation than can be placed at my disposal, but it may be indicated in a few words. Suppose we have a disc of tin charged with positive electricity. The charge on the disc does not cause any rotation of the vortices. The theory merely supposes that the particles in the dielectric undergo displacement; they are all pushed away from the tin, and they consequently deform and distort the vortices by tangential pressure. The vortices exert an elastic pressure at right angles to the direction of displacement—that is, at right angles to the lines of force. Now if we suppose that there are two discs facing one another, and that both are charged positively, none of the lines of force will cross a plane intersecting the space between the two discs. They will all curve away until they are parallel to that plane. If, therefore, the lines of force proceeding from the two discs are, for the greater part of their length, parallel to one another, and to the planes of the discs, it is evident that the pressure of the vortices (which is at right angles to the lines of force) will tend to separate the discs from one another; or, in other words, the discs will repel one another.

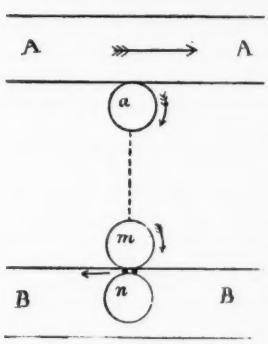


FIG. 8.—INDUCTION OF CURRENTS IN PARALLEL WIRES.

In the foregoing description I have only touched, as it were, the fringe of the subject. Nothing has been said about the substance of the dielectric or of the conductor. The beauty of the theory can only be fully realised when we see how it applies, when we come to consider the question of "specific inductive capacity" and the density of the medium. It would, however, be impossible to explain in a simple manner this important but difficult part of the subject; and those who have followed me thus far and desire further information, will find it in Maxwell's own writings and in the works above referred to.

In conclusion, the reader should perhaps be cautioned against taking the theory to mean more than was intended by its author. "The conception," he says, "of a particle having its motion connected with that of a vortex by perfect rolling contact may appear somewhat awkward. I do not bring it forward as a mode of connection existing in nature, or even as that which I would willingly assent to as an electrical hypothesis. It is, however, a mode of connection which is mechanically conceivable and easily investigated, and it serves to bring out the actual mechanical connections between the known electro-magnetic phenomena; so that I venture to say that anyone who understands the provisional and temporary character of this hypothesis will find himself rather helped than hindered by it in his search after the true interpretation of the phenomena."

HOUSE-FLIES AND BLUEBOTTLES.—V.

By E. A. Butler.

LIKE many other insects, the two house-flies are subject to the attacks of a parasitic fungus which destroys great numbers of them, especially towards the end of autumn. We sometimes see the corpses of such as have met this fate glued to the window-panes in the attitude of life, with legs widely spread and wings raised as if in preparation for flight, but with a white halo on the glass all round them, and with bodies pale, unhealthy looking, and distended. The spores of the fungus, which are excessively minute and are present in the air, are carried against the fly's body, and such as strike its under surface may become adherent, when each spore sends out a long tubular projection which penetrates the skin and enters the body. Once here, its host's doom is certain, for it meets with suitable nourishment in the shape of the fluids of the fly's body, by aid of which it will speedily propagate itself until its victim, drained of its life support, finally succumbs. The thread-like tube first produces a series of detached, rounded bodies, something like the cells of the yeast plant. These cells, which have an indefinite power of self-multiplication, are carried by the blood to all parts of the body, and thus the disease spreads. They, in their turn, give rise to a number of branching tubular threads, similar to those of the earlier stage, which in process of time penetrate the skin. Each thread which thus makes its appearance outside gives rise to a sort of head, which contains spores like those with which the series started. These are cast off with considerable force, and multitudes of them no doubt perish, while others are ultimately wafted against the bodies of other flies to deal destruction among them as among their predecessors. The particular species of fungus which makes havoc with the house-flies is called *Empusa muscæ*, and is one of a group which are distinguished by their habit of subsisting upon living insects. The maturation of the fungus involves the death of the fly, the fluids of whose body serve as food for the parasite. Under its attack, the fly becomes gradually feebler, and finally quite unable to move, and then the viscid secretion from the pads on the feet hardens and glues the insect to the surface to which it is clinging, while the fungus spreads round it and leaves some of its spores adhering so as to form the halo above described.

Besides the five species of which we have hitherto been speaking, there are several other *Muscidæ* that frequent our houses, though perhaps none to so great an extent as those already described. One of the commonest of the less familiar species is *Cyrtoneura stabulans*, which is at times almost abundant enough to be classed with the other five. It is a very widely distributed insect, occurring in the neighbourhood of dwellings not only in Europe but in America and at the antipodes as well. As its name imports, it is frequently abundant in stable-yards. It is a robust

dirty grey insect, in size ranking next the bluebottles. The thorax is distinctly marked with four dark longitudinal streaks, consisting of the usual bare patches amongst the grey tomentum; the tip of the triangular hinder termination of the thorax is reddish, and the legs, except the tarsi, are of a clear yellowish or reddish brown. The neuration of the wings (Fig. 13) is very similar to that of *H. canicularis*, but the chief nervures are pale at the base. These few characteristics will probably enable the insect to be recognised. At the moment of writing, it is sharing the window-panes with the smaller house-fly and a bluebottle.

The habits of this fly are apparently very varied. Its larvæ have been usually said to live on rotten fungi, but no doubt they also eat decaying vegetable matter of other kinds, and, judging by their abundance in stable-yards, apparently they devour manure as well. But that they are not confined to such diet is proved by the following observations of Mr. J. E. Fletcher; writing in October 1883, he says:—"For several years I have grown a patch of shallots, being uniformly successful with them until last year, when they were moderately attacked by Diptera, which, however, I was glad to find, as I was desirous of breeding them. I noticed two species of larvæ, one much larger than the other, and when the imagos appeared in the autumn and following spring, they proved to be *Cyrtoneura stabulans* and *Phorbia cepetorum*, Meade. This year, about a peck of shallots were planted, which should have yielded a crop of, say, seven pecks; instead of which they yielded little more than a quarter of a peck, the rest having been utterly spoiled by larvæ of the Dipterous insects named." As the pupæ of these insects are formed underground, no doubt in the above instance members of the autumn brood survived the winter in the pupa condition, and the ravagers of the second year were the offspring of these; hence the advisability, apart from any other reasons, of not sowing onions two years in succession on the same ground. As many of the *Muscidæ* are destructive to living plants, their larvæ either forming galls, mining in the leaves, or causing, as in the instance quoted, a rottenness of the part affected, there is nothing unusual in the above occurrence, except that an insect which is generally credited with being a dung-feeder should unite with such habits that of feeding upon living plants. But a much more remarkable change of diet has been recorded of the same insect; it has been found by Professor Riley to be an internal parasite of the so-called cotton-worm of America, its maggots feeding upon the viscera of the insect in the same way as those of ichneumon-flies. Such parasitism, again, is a habit of other *Muscidæ*, and the peculiarity in the present case consists simply in the abandonment of a vegetable for an animal diet, for which it is difficult to conceive the inducement.

Fig. 13.—Wing of Cyrtoneura stabulans.

By far the handsomest of all our household Diptera is the Greenbottle, which, though extremely abundant out of doors, is only an occasional visitant indoors; it is, however, closely associated with man and his surroundings. Its body is of a most brilliant metallic golden-green colour, whence its popular name. Its scientific name is *Lucilia Cæsar*. Its habits are similar to those of *Calliphora*; it attacks meat, but is more frequently seen on raw flesh than on cooked, and preferably seeks that in which decomposition has already set in; it is a great pest to fishmongers, and a piece of stale fish is sure to be a great attraction. It also frequents excrementitious matters in large numbers. It is as prolific as the bluebottles, laying from 300 to 600 eggs, and, like them, is in its larval condition essentially a carrion feeder. That carrion is its most natural food has been decisively shown by the experiments of M. Portchinski, a Russian entomologist, who placed eggs of three different species of flies on each of three different food substances, and carefully watched the results. The species experimented upon were the present insect, one of the bluebottles (*C. erythrocephala*), and one of the flesh-flies allied to the *Sarcophaga* already mentioned; and the food-stuffs were meat, cattle-dung, and decaying mushrooms. The eggs soon hatched, and in all three cases the maggots derived from those that had been placed on the meat throve rapidly and soon completed their metamorphoses; while all the rest grew but slowly and finally perished, with the exception of one batch, viz. those of *L. Cæsar*, which had fed on the cattle-dung; these, however, grew much more slowly than those of the same species that had been fed on the meat; still they survived and finally completed their metamorphoses. All that had been placed on the rotting fungus died without exception. Carrion, therefore, is the natural food of the larvæ of the Greenbottle, though they will subsist on excrement, and those of the Bluebottles are still more emphatically carnivorous.

Though the Greenbottles and Bluebottles are so different in appearance as perfect insects, their larvæ are very similar, and in fact, as Sir John Lubbock has pointed out, the form of a larva is dependent not only upon the type of insect it is destined to produce, but also upon its environment, so that those which live under similar conditions may be expected, for that reason, to be more or less alike, however dissimilar the perfect insect may be. This law is strikingly exemplified in several of the carrion-feeder flies, whose larvæ are sometimes almost undistinguishable though the flies are totally alike.

As regards adornment, *L. Cæsar* is really a splendid insect, and so far well deserves a detailed examination. But beauty is only skin-deep, and *Cæsar* is rather like a whited sepulchre, so that on the whole it is best to avoid too close contact, as its food usually betrays its disgusting nature by imparting more or less of an offensive odour to the insect. If one should gain entrance to a room and become annoying by its buzzing, and if death be in consequence decreed against it, it is well to remember that it should on no account be crushed, for if it has come direct from a meal its digestive tube is pretty sure to be filled with a most fœtid fluid, which, when exposed, will not be slow to make its presence disagreeably manifest. And in this connection it should be noted with regard to flies in general, that if they are to be killed by crushing, it is not sufficient to crush the abdomen. The most vital part is the thorax; here are situated some of the largest parts of the nervous system; serious damage done to these nerve centres is irremediable, and death follows at once. Not so, however, with regard to the head and abdomen; the latter may be crushed, or even removed entirely, without by any means destroying life, and a fly which has received such damage to its abdomen that parts of its contents protrude, will still continue to run about as though nothing had happened. The destruction or removal of the head of course puts an end to the action of the organs of sense

unless any such capability is located in the halteres, but it by no means deprives the insect of the power of movement. The decapitated head, which contains those ganglia that may be regarded as equivalent to a brain, soon ceases to show any signs of life; but the body, if touched, will for hours after decapitation respond to the stimulus by reflex movements of the legs and wings. The ganglia in the thorax, therefore, are all-important as the centres of animal life, and it is by crushing *them* that the life of the insect is most effectually and speedily destroyed. There is all the more reason for this with the *Muscidæ* than with other insects, because of the remarkable concentration of the nervous system in that family. The whole of the ganglia belonging to that part of the nerve-chain which lies behind the head have become fused into one mass, and that mass is situated in the thorax (Fig. 14); it may easily be discovered in a blue-bottle by removing the skin from the upper surface of the thorax, and then cutting away the masses of muscle which are thus exposed, as well as that part of the alimentary canal which lies immediately beneath them. The nervous mass is then seen as a whitish body from which threads pass in various directions. This dissection should be performed under water.

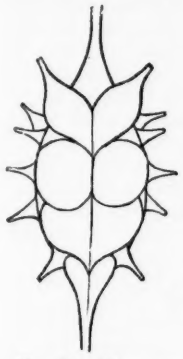


FIG. 14.—THORACIC GANGLIA OF BLUE-BOTTLE. After Lowne.

There is a very pretty fly called *Pollenia rudis* which is often common on the window-panes in the spring, before *M. domestica* appears. It is about the size of the latter species, and hibernates in the house, whence its presence on the windows. It is of a shining brownish black colour, the thorax being sprinkled with thin golden hairs in addition to the black bristles which are scattered over the body at large. The abdomen is very pretty, but is difficult to describe, inasmuch as the distribution of colour varies with the position in which it is seen. On each segment there is a pattern of patches with zigzag outlines, some of which appear ashy grey, and the rest deep brownish black; but it depends entirely on the light which of them shall appear grey and which brown. The pale tint is that of the tomentum, while the dark is the real colour of the skin, and according to the angle at which the insect is placed, the one or the other becomes the more plainly visible. Thus, if the fly be turned towards the source of light, the patches marked a_2 and b_1, in Fig. 15, appear brown, and those marked a_1, b_2 pale grey; but if it be turned round in the opposite direction, the colours are reversed, and a_2, b_1 appear pale, and a_1, b_2 dark.

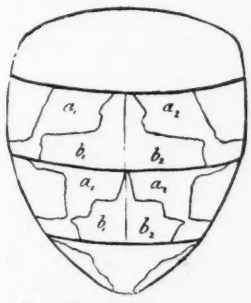


FIG. 15.—ABDOMEN OF POLLENIA RUDIS, female.

Very little is known of the earlier stages of this fly, but the perfect insect is often common, and occasionally even becomes a great annoyance. The worst instance on record is one from the United States, where the insect is called the "Cluster Fly." Professor Riley gives the following extract from a letter descriptive of the visitation which occurred at Geneva, N.Y.:—"They were at once a terror to all neat housekeepers, and from their peculiar habits a constant surprise. People soon learned to look for them everywhere; in beds, in pillow-slips, under table-covers, behind pictures, in wardrobes, nestled in bonnets and hats, under the edge of carpets, &c. A window-casing, solidly nailed on the wall, when removed, showed a solid line of them from top to bottom. They like new houses, but are also found swarming in old, unused buildings. But most of all they like a clean dark chamber, seldom used, and, if not disturbed, form in large clusters about the ceilings. Under buildings, between earth and floor, they are often found in incredible numbers."

(*To be continued.*)

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

LINCOLN'S INN GATEWAY.

To the Editor of KNOWLEDGE.

SIR,—You have given us a remarkable specimen of "simply-worded and exactly-described science," in four pages and two pictures of this gateway, which you and a few other people have been agitating to keep up till it has answered you by beginning to fall down. I have seen too much of Antiquaries and "Ancient Building Preservers"—by letting them go to ruin, to be surprised at anything from them; but I suppose you do not expect your discoveries in this new branch of science for KNOWLEDGE to pass unexamined. I give you the choice of having the examination done where you can make sure of replying to it, an advantage which you ought to appreciate. If you don't, you may fare worse elsewhere.

I admire your ingenuity in giving a scientific colour to your article by opening with five columns of biography of one Samuel Morland, who invented some kind of anticipation of a steam pump, and (for service of a different kind) got made "Master of the Mechanics" to Charles II. with a salary four times that of the Astronomer Royal; which enables you to shed quite a sidereal radiance over 24 Old Square, where he was clerk to Secretary Thurloe, who may also have been visited by Milton there, or somewhere else, where his papers were found, within walls which have already been wickedly rebuilt while you were asleep like Morland. For he was more remarkable for something else than his treatise on "The New Force of Fire."

According to the story of a more coeval biographer which you quote, the world was very near losing the services both of Morland and the sons of Charles I. by the dagger and pistols of Cromwell, who suspected the clerk of overhearing his discussion with Thurloe of a plot for inveigling the three princes over here from Bruges and shooting them as soon as they landed. But his master saved them all (whether to the advantage of mankind or not) by assuring Oliver that his clerk had been up for two nights and was asleep; which he was not, and secretly revealed the plot to Charles II. through somebody else. It is true that you think this sleeping story "theatrical and improbable," for the very poor reason that Morland not only kept the secret from Cromwell but afterwards "enjoyed his confidence; nevertheless he had to fly to Breda on account of some (other) dishonourable breach of confidence," which you had previously said seemed to confirm the story. I do not care which theory is right. Anyhow, that was a very

nice little party of traitors and intending murderers—or else the whole concern goes to pieces—to have diffused a perpetual odour of sanctity not only over the room where they met, but over the whole region roundabout, so as to make it impious "Vandalism" to rebuild a ruinous house three doors off No. 24. (The Vandals were notorious restorers of waste places, as every antiquary and ruin-preserver knows, if nobody else does.)

And so collapses all the fuss that you and your associates have been making for years about this gateway being sanctified by the presence of Cromwell and his secretary, neither of whom do you now pretend to have been inside it. If they had both lived there, and if your nonsensical doctrine had been accepted for the last century, while London has been getting somewhat regenerated from the squalid and ruinous state into which it had got "developed," as you say this gateway has, it would have been a truly nice and healthy and convenient place to live and move about in by this time. For there could hardly be any considerable old street or square in which somebody or something did not live or happen for people like you to rave about and scream against improvements. And any old building can be called "interesting" to people who have not to use it.

As for the gateway itself, it would be a waste of time to contradict you about its beauty, as that is a matter incapable of proof, and everybody thinks himself as good a judge of it as anybody else. So I gladly abandon it to your admiration, and content myself with calling it now a mean, ugly, and good-for-nothing fabric, whatever it may once have been, and the chambers quite unfit for modern habitation. Building is a practical art within the dominion of science and common-sense. Vandalic Acts of Parliament and public surveyors no longer tolerate unsafe or uninhabitable buildings for the admiration of silly sentimentalists. So there you are within the reach of reason. You have evidently learnt all you wanted to learn, and more, and you know, or it is your own fault if you don't, that the second architect whom the Bench were consulting, with a view to preserving the gateway by what is called "restoration," voluntarily warned us that it is in immediate danger; and so it was tied up for the present in the way that you describe, though that is far from representing the amount of less immediate danger in other parts of it.

Nevertheless, you think it honest and decent to insinuate that that warning was a mere "assertion" by some prejudiced and incompetent persons, to make a false appearance of danger by those "iron ties and wooden framework which give it a most decrepid appearance." Nor do you leave it doubtful whom you mean to indicate by those persons, and especially one of them; and who also, "with or without the direct authority of the Bench (which of course means without), stripped some of the rooms of their panelling, and removed, very improperly, in your opinion, some of the (modern) supports of the timbers over the windows, *professedly* to trace the course of a few old settlement cracks," as you are pleased to call large splits right through the walls, which convinced the most unwilling Benchers that I and the Clerk of the Works had been right before in saying that it is altogether past any kind of restoration but rebuilding from and with the foundations. All this I know that you have seen, and therefore have no excuse for such misrepresentations as you have published.

In fact, you have seen so much that you tell us exactly what we can and ought to do. "If necessary, the walls might be thickened where they have been interfered with." Probably people without building experience cannot realise the utter absurdity of such a suggestion for reviving such walls as those, split and bulged and rotten in every way, and showing all the known symptoms of danger. Only there are no such symptoms known to antiquaries and "preservers," who always tell one that "it has stood firmly and safely for 300 years," as a proof that it will stand for 300 more; and therefore, so on, *ad infinitum*. Then, "there is no doubt that a clever engineer can make any building secure without disfiguring it." Fancy turning in an engineer, of all people in the world, to make an ugly and falling building beautiful for ever! Those who are profoundly ignorant of anything are always sure that somebody else can do what they want. It is fair to both the architects to say that they admitted that very little of the original walls could survive in any so-called restoration. It is quite clear now that none would. Consequently, a restored or copied gateway would combine all the faults of antiquity and novelty.

Your financial dicta are as valuable as your architectural. "Rebuilding is a costly affair, and could not for a moment be defended from an investment point of view." Couldn't it? You do pay me (and you should add our clerk of the works) the compliment that I have built more substantial and convenient chambers than architects did while we employed them. I believe you know, too, that we have suffered much less from the well-known disease of "extras." On our last contract, of nearly £20,000, we had none. You admit also that the small and sole surviving rent from the gateway was moribund before the warning that it is unrestorable, and it must be considered dead financially. Why then do you choose to say that rebuilding cannot pay? You either know nothing at all about it, or you know that we have a plan for rebuilding it in the original style (not your "developed" mongrel) with chambers of the most desired sizes, and as good as any in the Inn, which will make a far better investment than we have or can get in any other way. Some years ago, Sir George Jessel told me they had asked him at the Temple how we managed to make our new chambers pay while they could not. I leave you to divine his answer because you know how ours have been done, and even the architects kept in some order. We have had two more rival designs, of which one has been already rejected by a large majority, and certainly would have been a bad investment, besides its architectural and practical defects; and the other avowedly was to earn no rent at all, though it was to cost some thousands, and would only earn the ridicule of mankind, and end in being pulled down again in a few years. Not that I blame the architect for them, seeing that he did what he was told, as well as he knew how. Some Benchers wanted to see the effect of that kind of thing.

You have made even your photograph deceptive, by excluding the new buildings which overpower the present rubbishy structure; while everybody knows, and you might have learned at Cambridge, that a turreted gateway should always predominate over the adjacent buildings. You had better stick to celestial phenomena, and not lecture on such earthly things as bricks and mortar and finance, until you have learnt a little more about them; and still less, tell your pupils, the owners and managers of this building, that they are mostly fools and some of them rogues.

June 8. Grimthorpe.

[I can assure Lord Grimthorpe that he need not use a threat to induce me to publish his letter. If I had none of the leanings to fair play which would make me scruple to suppress what purports to be an examination of my

statements, I should still be only too happy to publish this letter, in which Lord Grimthorpe so frankly takes the responsibility of the proposed destruction upon his shoulders, and affects to give reasons for it, which can now be examined.

Lord Grimthorpe says that the re-building will make a far better investment for the Inn than can be got in any other way. When I wrote that the re-building could not be defended from an investment point of view, I imagined that the Inn was getting from one to one and a half per cent. on its re-building operations, and, without pretending to any exceptional financial knowledge, I knew that I might safely venture to point out investments where more than one and a half per cent. can still be obtained. But, since receiving Lord Grimthorpe's letter, I have gone into the matter more closely, and am surprised to find that the large expenditure which he admits seems actually to have resulted in a loss of rent to the Inn. The block of buildings to which Lord Grimthorpe refers as having cost nearly £21,000 consists of two staircases, Nos. 14 and 15, with the same number of floors and sets of rooms on each staircase as there were in the old ones. But the new block of buildings occupies about the space which was formerly occupied by three staircases. The new rooms are larger and loftier than the old ones, and are, of course, higher rented; but it appears from the information with respect to the old rents that I have been able to gather, that the new rents are not fifty per cent. higher than the old, so that the net result of the two staircases as compared with the three, seems to show an actual loss of rental; and when we take into account the whole building scheme, and the number of chambers which were done away with in order to make room for Lord Grimthorpe's expensive and unnecessary addition to Inigo Jones' chapel, it would puzzle even such an Old Parliamentary-Bar Hand as Lord Grimthorpe to make out that the Inn would not be much better off if their money were back again in Government Stocks.

The calculations of Lord Grimthorpe with respect to his last block evidently ignore the old rentals. He treats this land in the heart of London as if it might fairly be taken at what the land agitators call a prairie rental, which, according to Lord Grimthorpe's theory, seems to be no rental at all. Even if we assume, for the sake of argument, that the old buildings are as rotten as Lord Grimthorpe would have us believe, land abutting on Chancery Lane might be let at high ground-rents for shops or chambers to strangers; and before calculating the return on re-building schemes, such ground-rent values ought to be taken into account; but Lord Grimthorpe loves to exercise his ingenuity, and is not in the least daunted. It is evident that he saw this difficulty, for he turns it, or pretends to turn it, by telling me I admitted (which, by the bye, I did not) that the old rentals were moribund, and he forthwith proceeds to treat them as dead, and the ground as worth nothing. What I did say, and what so plain-spoken a philosopher as Lord Grimthorpe will no doubt excuse me for putting in still plainer language, was that the old rental was being killed by the disgracefully dirty and unpainted condition in which these old chambers have been kept. I believe that I am right in saying that the external wood and iron work has not been painted for ten years. As an architect remarked to me: "It is evidently intended that these buildings are to come down." New tenants have not been encouraged to take chambers in the doomed houses, but in spite of this, several of the old tenants still remain, and intend to stick to their convenient oak-panelled and amply cupboarded old rooms till the destroyer drives them out. In connection with these empty chambers, it should be noted that Lord Grimthorpe's new block close by, of which he obligingly gives us the cost, are not yet all tenanted, though the rooms, all spick and span, have stood empty since they were finished in 1887.

One may dismiss very shortly the assertion that the gateway and old buildings adjacent are dangerous. Lord Grimthorpe knows as well as anybody that District Surveyors have duties with regard to dangerous structures, and that our legislators have arranged that District Surveyors should be paid by fees on giving notice with respect to dangerous structures, and again by fees on inspecting the re-building which generally becomes necessary as a result of such notices, so that it has become the interest as well as the duty of District Surveyors to look sharply after structures that are dangerous. Any member of the public can draw the attention of the District Surveyor to a building which he believes to be dangerous, and we may safely assume that this is not a case in which it has been possible to remove by so simple a process the buildings which now obstruct Lord Grimthorpe's plan, or rather the plan of Sir Gilbert Scott, whose scheme to re-build the whole of Old Square was accepted by the Benchers, and has been adopted by Lord Grimthorpe, who now shows such evident anxiety to carry it out that we can hardly expect his statements with regard to the safety of the buildings to be as unbiassed as that of an ordinary professional man.

It is curious how very opportunely the various blocks of Old Buildings have one after another been found to be "dangerous and rotten" just about the time that Lord Grimthorpe has finished the block alongside. One has only to use one's eyes to see cracks in nearly every large building which stands on such elastic soil as that of the London Basin. Sir Christopher Wren was well aware of the existence of such settlements in St. Paul's; but having satisfied himself that they were not going farther, he took no heed of them.

What Lord Grimthorpe's real opinion is, with regard to the safety of the Gateway, may be gathered from the fact that he and those who advise with him have tied up the front, said to be dangerous, not with iron or steel rods, but with *iron* inch gas piping. No chain is stronger than its weakest link, and the ponderous wooden balks of timber shown to the public on the Chancery Lane face of the building, are only held in their place by pieces of iron gas piping, the lengths of which are screwed together with short links or nuts, the thread of the screw in which is about a sixteenth of an inch deep. That such an iron screw would strip with a very slight strain is a fact that does not need explaining to Lord Grimthorpe—the inventor of the gravity escapement pendulum. In this iron thread we have a sort of fossil evidence, better than any verbal admission, that Lord Grimthorpe knew that there would be no strain on his tie-pipes, and that he knows that the walls have not been pulled into the perpendicular by the paltry strain put upon them. One might as well try to make the tower of Pisa stand erect by pulling at it with a watch-chain.

I have verified the levels of the brick and stone courses on the Chancery Lane front, and have satisfied myself that the footings of the wall have not sunk an inch, in spite of the underpinning for the foundations of the adjacent building. There are recent level marks on the Chancery Lane front which practically agree with my measures—so I concluded that Lord Grimthorpe had been there before me, and knew that there had been no settlement of the footings.

I have ventured to say that Lord Grimthorpe was evidently aware of these things, because I do not think he

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would willingly expose to danger the innocent passers-by in Chancery Lane, or the tenants who remain in the Gateway.

I will leave it to professional architects to deal with the question how these old buildings can be best preserved, remarking that the three gentlemen Mr. Crickmay, Mr. Micklethwaite, and Mr. Webb, who have been consulted professionally, are all well-known architects who have had wide experience in the preservation (I do not say restoration) of ancient buildings.—A. C. RANYARD.]

REPORTS ON THE GATEWAY TO OLD SQUARE, LINCOLN'S INN.

To Mr. A. Cowper Ranyard, as representing the Members of Lincoln's Inn and others who signed the petition to the Benchers presented in Dec. 1885.

DEAR SIR,—At your request I have made a careful examination of the gatehouse and gateway leading to Lincoln's Inn from Chancery Lane, and from my large experience in connection with the restoration of ancient buildings I am able to say, without the least hesitation, that this building is not in such a state as to require its removal—in fact I find it to be, with few exceptions, in a sound and substantial condition, and this notwithstanding the excavation for the new buildings on the north side, and a considerable amount of cutting about which has taken place at various times; and I further say that the ties recently put in for the purpose of keeping the building together are quite unnecessary, and in fact useless.

There is no doubt that in consequence of the cutting about that has taken place it is advisable shortly to execute some repairs, and these consist principally of rebuilding the inside of the wall where it has been cut away on ground, first, and second floors at the north-west corner in Chancery Lane, tying the same thoroughly into the outerwork.

There has also been an excavation made for a cellar under this corner, and continuing along on the east side, which excavation was carried down below the bottom of the foundations, notwithstanding which the wall stands fairly firm and substantial. I advise that this cellar shall be filled in with concrete so as to back up the wall.

There are other parts of the building which require to be taken out and rebuilt and bonded into the old work, such as the arch over the ground-floor window up to the sill of the window over.

The parapet next Chancery Lane should be taken down and rebuilt; and the brickwork where split at the south-east angle of north tower, and the north-east angle of south tower, about ten feet down at the upper part of the wall, should be carefully taken out and rebuilt. Also on the west side of the south tower a cracked portion should be taken out and rebuilt, and the cracks cut out on the inside of the wall and tied to the other work with ties of brickwork in cement. Occasionally a few bricks should be taken out, the loose mortar removed, and the cracks filled in with cement grout.

The large stack of chimneys at the south end are in a very sound and substantial condition; but the centre chimney stack to the south tower, next the gateway, should be taken down to the level of the roof and rebuilt.

Wherever the face brickwork is removed, care should be taken to re-use the old bricks, which should be well bonded into the other work, and set and grouted in cement.

I recommend that a scaffold be erected, and the whole of the joints of the external brickwork raked out very deep and carefully re-pointed with good mortar; and wherever the brickwork is split, the opportunity should be taken of removing the brickwork where cracked, and bonding it carefully in, bedding the same in Portland cement.

If further proof is required of the stability of the building, notice should be taken of the plaster ceilings, which are in very good order indeed for a building of this date—in fact, better than may have been expected.

At some time the wall on the north side of the gateway has been removed, a bressummer inserted, and a column placed in the centre to shorten the bearing, and to assist to support the bressummer. This has caused a small settlement, and it would be well to examine the bressummer to ascertain whether it is sufficiently strong to carry the weight above; and if not, means should be taken to strengthen it.

The lead flats are modern, and the slight timbers supporting the same. It would be well to take up the principal parts of the flats, put stronger bearers to support them, and recover them with lead. I recommend that it should be *cast* lead, not milled, as being more in character with the old work, and a better and more satisfactory job.

When the foregoing work has been carefully done and completed, I have no doubt whatever that this old gatehouse and the gateway will be thoroughly sound and substantial, and will stand all the vibration of the passing traffic, and, if properly looked after, will remain good at any rate for another hundred years.

Yours faithfully,
G. R. CRICKMAY, F.R.I.B.A.

17, Parliament Street, Westminster, S.W.
June 25th, 1890.

To Sir Frederick Pollock, Mr. Walter Bailey, Mr. F. T. Procter, and Mr. E. P. Fry, as representing the 281 *Members of Lincoln's Inn who signed the Petition of* 1889.

GENTLEMEN,—According to your directions I have made a careful examination of the gatehouse between Old Square and Chancery Lane, and I now send you my report on it.

The gatehouse is of red brick with grey flared headers arranged in a lozenge-pattern in the style of the older parts of Hampton Court Palace, with which it is contemporary. Some alteration was made about a hundred years after the building, and since then there have been continual alterations of parts, which have left a picturesque irregularity not less pleasing to the eye than more formal architectural lines would have been. The walls have been much patched and refaced, but I do not think that any parts except the parapets and chimneys have been taken down and rebuilt.

Considering all that it has gone through, the condition of the fabric is remarkably good. There are, indeed, some ugly fissures sufficiently alarming to people without practical knowledge; and the effect of them is heightened by the tie-bars which have lately been inserted. But the fissures are due to causes which may easily be removed, and the tie-bars have more effect in the creation of panic than in the support of the building.

The smaller entrance from Chancery Lane is an insertion made at the expense of the ground-floor chamber on that side, the south wall of which has been taken away. This caused the removal of the vaulting, if it ever existed, over the passage of the gate, and it took away the solid support from the wall above which is now carried only by a pillar. It is in this wall that the most serious rents are found; and it needs only a proper under-building, which

may easily be done without interfering with the convenience of the gate, to make it quite good and safe. The shop front inserted in that part is also a source of weakness which may be remedied.

Most of the other cracks and settlements, no one of which is serious, are due to want of care in the insertion of the windows, and may be cured by making good the heads of them. Seeing that in some places the windows have been inserted one above the other from the bottom to the top of the building, it says much for the substantial soundness of the old walling that it has been so little affected. The same is proved in various places inside, where the brickwork has been recklessly cut away without serious consequences following, and in the north-east corner where a cellar has been dug out much deeper than the foundations and close to them. Here there is a slight settlement in the corner visible in Chancery Lane, but it extends a very short distance, and the plinth throughout is level, showing that there has been no other settlement in the foundations. The walls are generally upright, and not more irregular than is usual in a brick building of the age of this one.

The floors have been opened in several places, and show the oak joints to be in excellent condition, and as fit for their work as they were when first put there. The stairs, which are of solid oak blocks, are perfectly sound though worn with use. I could not get into the roof, but I think it is not the ancient one. Part of it has been re-leaded lately, from which we may infer that its state was not found to be very bad.

I have no hesitation in saying that the gatehouse may easily be repaired, and that it is not necessary to pull it down. I advise that it should be kept in its present form with only such changes as may be necessary to its permanent stability. To take away the changes which have been made during the last three centuries, and to put instead an academic "restoration" of what the gate may have been in Henry VIII.'s time, would be to reduce to the level of modern common-place what is now a picturesque relic, interesting from its connection with names which live in history, but more so as a record of the ways and manner of life of our fathers, such as only the buildings they used can show to us. In a busy town like London such buildings must become fewer each year, and therefore more precious. Private owners may perhaps plead the necessity of getting the fullest value out of their property. But no such need presses the owners of Lincoln's Inn; and I hope that that ancient Body will value the visible evidence of its antiquity which this gatehouse and the buildings south of it affords, more highly than any increase of rental which might be got by their demolition.

And I remain, Gentlemen,
Yours very faithfully,
J. T. MICKLETHWAITE.

15 Dean's Yard, Westminster, S.W.,
21st May, 1890.

(*To the Acting Committee of the Society for the Protection of Ancient Buildings.*)

GENTLEMEN,—According to the request made by the Committee, that I should examine and give my professional opinion on the present state of the fabric of the Gatehouse entrance to Lincoln's Inn, Chancery Lane, I beg to say I visited the building for that purpose on Friday, the 20th June, having been permitted by the Inn to go about and over all parts of the structure, not only without hindrance, but with assistance.

I will state at once that I have for years past observed what has been going on in the way of building in the Inn from time to time, from when the addition was made to the library down to the present moment, watching the works of pulling down and rebuilding blocks of chambers, transforming the chapel, and the rest; noting, from time to time, the changes made in the appearance of the place, and the methods employed in rebuilding.

I have also repeatedly looked at the Gatehouse, and seen with regret that the necessary repairs to this building were over long deferred.

The structure itself has suffered—as almost all old buildings have—from careless caprice in the alterations made from time to time to suit change of use; and the ordinary precautions necessary to be observed when making the most superficial, as well as radical disturbance, seem to have been neglected.

For instance, in this gateway, for some reason in past time, the wall between the wheel and wicket ways was taken down on the ground story, and an iron column substituted to support a beam to carry the weight of walling above. This alteration seems to have been done in a clumsy unworkmanlike manner, and a settlement-crack was the result.

In noticing this, amongst other effects of alteration, I was curious to see if the east and west ends of the upper part of this wall, where they are attached to the archway walls, shewed signs of separation at the angles, and I was glad to find there was little or no sign of weakness there. The enlargement of the original openings, or new cuttings, to admit of the introduction of ordinary sash windows in the centre west wall, made a serious call upon the strength of the fabric on the right side of the arch; and a narrow crack, of long standing, shows from top to bottom in the wall of the adjoining stair turret. This is a useful point for examination as, though the alteration was made in a rude and venturous way, the stability of the structure was not ruined by it, and it has borne the strain better than could have been expected.

I gathered from the Clerk of the Works that, when digging for the foundations of the new buildings adjoining the Gatehouse on the north side, at eleven feet below the surface of the ground, solid gravel was come to, and that above that depth the earth was loamy clay: also, that when the new footings were put in, parts or the whole of the gateway-wall in contact with the new buildings were underpinned. If this was so, the underpinning must have been well done, as some settlement generally occurs from all underpinning, and there was no sign of this here, so far as I could see at the time. However, supposing this wall, or parts of it, to have been underpinned properly, the Gatehouse is now so much the more secure from movement. Generally, throughout the structure, I could find no dangerous settlement whatever, and the signs of mischief in the way of cracks, bulges, separations in the thickness of walls, &c., of which one finds so much, as a rule, in all old buildings, seem to be in this case only of the most ordinary kind, and easy to be dealt with in the way of repair. In fact, the many and careless cuttings, from which the walls have suffered at various times, tend to prove that the brick structure on the whole was a sound one, or it would have suffered more than it has.

There are the usual "plank lintels" to the enlarged window openings, and other poor building contrivances put in without proper consideration; but the original timbers, where I could see them, seemed to be of sound English oak, cut more squarely and regularly than was common. The floor beams and joists will probably prove to be sound for the greater part, and where decayed could be easily replaced with new.

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Some of the lead-flats to roof are in a fair condition, though others, having been laid with too large sheets of lead, show the usual signs of failure from that cause.

The window fittings, of various character of wooden sash frames and casements, are generally poor or worn out (the older being the more sound), and should be properly renewed. The panelling to walls, which has in some rooms been removed to allow of examination of walls would, in most cases, be serviceable for re-use.

I have no hesitation in saying—after only a three hours' survey of the state of the fabric—that there would be no difficulty whatever in soundly repairing the building, and making the different rooms in it comfortably habitable, and at a comparatively small expense.

The works might be conveniently done mostly from the inside, so that very little displacement of the external face of the walls need occur. I am also of opinion that every part of the building should be attended to, from the foundations to the chimneys.

That the work might well be done, under the care of a competent Clerk of the Works, from the clear instructions of a practical surveyor, as I saw no serious difficulties to be overcome, it being here understood that reasonable works of repair alone would be undertaken, and that no transformation of the building would be entertained; for the object in view, I presume, would be to bind up and strengthen, and not to do further injury.

(Signed) PHILIP WEBB, Architect.

1, Raymond Buildings, Gray's Inn,
June 21, 1890.

ON THE DISTRIBUTION OF STARS IN THE MILKY WAY.

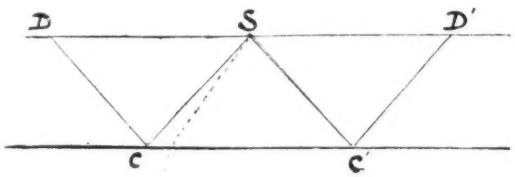
By A. C. RANYARD.

THE exquisite photographic plates which illustrate this paper have been prepared from an enlargement and six contact copies from original negatives kindly made for our readers by Professor Barnard of the Lick Observatory. They are well worthy of close examination, for they afford the reading public an opportunity of studying the structure of certain rich portions of the Milky Way, such as only the possessors of the largest telescopes have hitherto enjoyed. Indeed, I am probably right in saying that these plates show more of the structure of the Milky Way than can be seen by the eye with any telescope, for the gradations of brightness are accentuated, if smaller stars are not shown, and the eye can never grasp at one time, in the eye-piece of a telescope, as wide an area as that presented in these photographs. For example, the region of the heavens depicted in the enlarged photograph is more than seven degrees in diameter, and the smaller photographs correspond to still larger areas which may be calculated from the scale values given beside them; whereas in a large telescope a field of one degree in diameter can only be examined with a very low power, and the higher the power used the more the field of view is contracted, and contrasts of brightness are lost.

The photographic plates will bear examining with a hand magnifier, when it will be seen that many of the regions which appear to the naked eye to be tinted with a uniform tint, break up into a stippling of points corresponding to minute stars. The stippling is so fine that ordinary paper could not be used, and paper with a specially prepared surface has had to be made use of. The stars at the centres of the plates are perfectly circular, while towards the edges of the plates the star discs become elongated in a manner obviously due to the optical distortion of pencils of light passing obliquely through the lenses used. On such a close examination it will be evident that many streaks and markings which at first sight might be taken for photographic stains or imperfections are really due to groups of stars.

Before discussing the probable forms of the star groups, as well as the physical meaning of the dark channels and spots, the existence of which cannot be doubted, we had better devote a few moments to an examination of some obvious photographic defects, the explanation of which is perfectly simple.

At the top of the enlarged picture is a great white patch surrounding the place of the planet Jupiter in the heavens. A similar dark patch is seen at the top of picture No. 2 on the other plate, and on the left-hand side of the picture immediately below it. These patches are produced by the reflection of the light of the planet from the back of the photographic plate during the exposures of more than three hours, necessary to obtain a photographic record of the fainter objects shown in the pictures. When the image of a bright point falls on the sensitive film of a dry plate, such as these photographs were taken upon, the small portion of the white opalescent film which is being acted upon, is brilliantly lit up, and shines like a little lamp, dispersing light in all directions within the thickness of the photographic plate. Part of this light is reflected from the back surface of the plate, and reaches portions of the sensitive film situated around the place of



the bright star. If S be the place of the star on the sensitive film, and C C′ the back of the plate, the intensity of the reflected light varies according to a curious law which is well illustrated on these plates. The light which falls nearly perpendicularly upon the back surface of the plate in great part emerges, and is lost in the space behind the plate; but a part is reflected, and on reaching the film on the front surface produces, if it is sufficiently intense, a photographic change. Of the dispersed light which falls more obliquely on the back of the plate, a larger portion is reflected, but it is dispersed over an area which increases with the square of the distance from the illuminated part of the film, so that the intensity of the photographic action of the reflected light at first decreases, till the angle of total reflection at the back of the plate is approached, then the intensity of the reflected light rapidly increases. Outside this limit the whole of the dispersed light is reflected from the back surface of the plate, and the intensity of the photographic action begins to decrease again with the increase of area over which the totally reflected light is dispersed.

In the right-hand lower corner of picture No. 2, and in the left-hand lower corner of picture No. 4 may be seen stars with well-defined circles around them. The diameter of these circles corresponds to the position of the rays reflected near to the critical angle when total reflection begins, a fact which I have experimentally verified and have shown that the diameters of the nebulous circles vary with the thickness of the glass plate upon which the

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Region of the Milky Way to the South-west of the Trifid Nebula.

E N
S W

From a Photograph taken at the Lick Observatory by Prof. E. E. BARNARD.

The White patch at the top of the picture is the over-exposed image of Jupiter. The Trifid Nebula is just within the border of this patch—nearest its lowest part. The dark patch referred to is near to the centre of the plate. Scale—1 inch = 1° 48′.

Direct Photo Eng. Co., Limited, 9, Barnsbury Park, N.

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photograph happens to be taken, and with the difference of the index of refraction of the glass plate and the material behind it.* This question is more fully discussed in the *Memoirs of the Royal Astronomical Society*, vol. xlvi., pp. 231-3, where I have given the intensity of the dispersed light which acts on the film at various distances from a central bright point. When the central star is bright enough, as in the case of Jupiter, the photographic action is sufficiently intense to fill up the interior of the circular area, and a uniform patch with a nebulous outline is the result. It will be noticed that the patch around the place of Jupiter in the plates is not quite circular. The deviation from the circular form is produced by the Trifid Nebula, which happened to lie close to Jupiter at the time the photographs were taken.

Picture No. 2 and the picture immediately below it, as well as the enlarged photograph, all represent the same region of the heavens; but it needs a little patience to compare them, for in the two smaller photographs the stars are represented by black points, whilst the enlargement is a positive print in which points of light are represented by white dots. The density of the printing has been purposely varied so as to be very different for the three photographs, and the enlarged copy is (for technical reasons) reversed right and left as compared with picture No. 2. The picture below No. 2 is a print from a denser photograph turned with its top to the right-hand, so as to show more strikingly the curved line or stream of stars which stretches like an arch across the middle of the picture. Its existence will be recognized in the enlargement as a dark channel or string of dark spaces, many of which are nearly circular, and are bordered by minute stars all of about the same brightness. There are other similar darkish patches bordered by stars on some of the brighter parts of the star clouds. Prof. Barnard has called special attention to one of these near the centre of the plate, which is strikingly visible in the telescope as a minute "coal sack." It is about 2′ in diameter, slightly triangular, with a bright orange star on its north preceding border, and a beautiful little cluster following. Its position in the heavens is about R.A. 17h. 56m., $\delta = -28°$.

After looking at this enlarged photograph, one can have no doubt as to the aggregation of stars in cloud-like swarms or masses. There stretches up from the comparatively uniform cloud-mass on the southern (that is, lower left-hand) side of the picture a complicated nebulous structure, which Prof. Barnard compares to breaking spray. It seems to spring from the larger cloud-mass towards the south, and its very complicated structure is perhaps best recognized in the smaller negative pictures. From these it seems to consist of many streams of stars overlaid by dark absorbing masses, which have a tendency to aggregate in lines more or less parallel to the great arch spoken of above. Of the streams of stars I would call special attention to the three diverging streams like the plumes of a Prince of Wales' Feather, which are best seen in the densest of the two small negative pictures, and, having been once recognized there, they can be traced in the other two. The plate should be held sideways, with the south-west side downwards, and the plume-like streams will be seen on the left-hand side a little below the centre of the picture. Overlying, or perhaps lying behind these streams, which seem to spring from the south-west, is another nebulous mass of stars of quite a different character. I call attention to these details, which need some patience to discover, because they seem to afford evidence that we are looking through an immense depth of stars—probably at one type of structure behind another—and that the Milky Way is not a mere ring or stream of stars in space, as some have thought, but that more probably there is a tendency towards aggregation in the "galactic plane," and that there are streams and star structures, one behind the other, near to this plane, which we see projected into the nebulous belt which encircles the heavens.

That some of the light from this direction of space is absorbed by dark masses, or regions rich in meteoric dust, is rendered probable by many considerations. We already know of the existence of many dark bodies in space, such as the companions which eclipse the light of Algol, and other stars of the same class, and the comparatively dark bodies which cause irregularities in the proper motions of Sirius and Procyon, as well as minor dark bodies such as comets and meteors; and, as remarked by Arago, if the ether is perfectly elastic and there is no absorption of light in space by such dark bodies, and all stars were comparable in brightness to our sun, the whole heaven would (if the universe were infinite and stars are distributed in every direction) shine with a light comparable with that of our sun.

The many small isolated dark patches on a comparatively uniform background of light are much more easily accounted for as produced by the absorption of foggy areas, or dark bodies, than as due to holes or gaps in the stellar clouds. Prof. Barnard's photographs seem to show that such dark areas exist, and that they are in some curious way associated with and surrounded by groups of small stars.

* The intensity of the light reflected from the back of the photographic plate may be very greatly reduced by placing a thick sheet of glass behind the photographic plate during the exposure, with a film of water and glycerine between the two. This is much better and cleaner than Capt. Abney's asphalt coating at the back of the photographic plate, which is troublesome to remove. The actinic action of the small amount of reflected light may be still further diminished by coating the back of the hinder plate with a film of red collodion, a method which I adopted at the Egyptian eclipse of 1882.

NEW LABORATORIES FOR WOMEN STUDENTS.—Bedford College, London, has just been building some new Laboratories in a wing adjoining the present premises, which will be ready for use next session beginning on 2nd October. The Laboratory arranged for Physics measures 35 feet by 37 feet, it has a concrete floor, and is fitted with excellent teak-topped benches and ample accommodation for apparatus. A lecture-room, to hold about fifty students, adjoins. There is a similar laboratory and lecture-room for students of chemistry at the top of the new wing. All modern appliances in the way of gas, water and ventilation to the working benches have been given, and every facility will be offered to independent research work. There are also in connection with Bedford College Laboratories for animal and vegetable biology or botany, so that women students of natural science will now have opportunities for Laboratory work in London offered them which will no doubt be fruitful in indirect, as well as in direct, results. All particulars as to hours and terms can be obtained on application to the Honorary Secretary at Bedford College, 8 and 9, York Place, London, W.

A DAUGHTER of Prof. Simon Newcomb is devoting her attention to the collection of statistics with respect to the Socialist communities of America, religious and otherwise, in continuation of the important work of Father Noyes, who, himself an ardent Socialist, chronicled the demise of so many Socialist experiments.

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Notices of Books.

Mungo Park and the Niger. By Joseph Thomson. (Philip & Son, 1890.) The editors of the "World Explorers" series, of which this is the third volume, have been fortunate in securing Mr. Thomson as writer of the memoir of the brave, ill-fated traveller whose pioneer work it was his privilege to skilfully complete. Mr. Thomson wields no halting pen; he has a stirring, pathetic story of pluck and privation to tell, and he has told it in a vigorous, sympathetic way that sustains our interest to the end. Apart from the biography, the book is a timely and valuable contribution to the literature of African discovery, in supplying a graphic sketch of early explorations of the Dark Continent, and carrying on the record, so far as the region of the Niger is concerned, from the time of Park to the present day. The reproduction of early maps of the Niger district is in the usual style of excellence in Messrs Philips' publications, and the book is further adorned with a portrait of Mungo Park and with woodcuts of places and people.

Chambers's Encyclopædia. Vol. V., Frid—Huma. (W. & R. Chambers, 1890.) This latest instalment of the new edition maintains the high level of its predecessors. Competent specialists have either written the acticles or revised them, so that in every case the information is up to date, rendering it somewhat invidious to commend here and there where all is well done. But as a model of sane explanation necessary to the mental health of some amongst us, who, like the silly women of apostolic times, are led captive by every fad that comes tricked-out with scientific name, we must call special attention to the pithy article on "Hallucinations." Biography is strongly represented, and a vast amount of information in portable compass is given in Mr. Hindes Groome's "Gypsies," Mr. Wallis Budge's "Hieroglyphics" and—most opportunely while Weismann's theories are under debate—Mr. Thomson's "Heredity."

Toil, Travel, and Discovery in British New Guinea. By Theodore F. Bevan, F.R.G.S. (Kegan Paul & Co., 1890.) Mr. Bevan informs his readers that he is descended on the paternal side from Celtic priests and princes, and, perhaps, for the family archives are not clear upon this point, on the maternal side from Captain Cook.

A comparison of the earlier and later maps of part of the south-eastern coast of New Guinea shows that we are indebted to Mr. Bevan's ability and pluck for several important discoveries, from the shores of the Papuan Gulf to the great rivers which drain a large tract of land south of the main central ranges of the island; and with this fact, to which the colonial authorities have testified, before us it is not pleasant to read of the unworthy endeavour of a Mr. Chalmers, one of the over-fussy missionaries settled there, to deprive Mr. Bevan of the credit which is his due for the additions made by him to our knowledge of hitherto imperfectly explored parts. There are plenty of interesting things about the Papuans in the book, but there is throughout rather too much about Mr. Bevan. The reason of this is that he has a grievance against the Government representatives in their refusal to grant him a good slice of land for the purposes of trade. Probably he would make good use of the land, but we have not heard the other side of the question, and therefore we must take Mr. Bevan's adverse comments on the results of the British protectorate *cum grano salis*.—E. Clodd.

TEETH AND THEIR VARIATIONS.

By R. Lydekker, B.A.Cantab.

(*Continued from page* 156.)

THUS far we have succeeded in tracing the gradual modification of the bunodont tooth of a true Pig into one with a selenodont form, although of a low-crowned type; and we may infer from this that the owners of the latter type of teeth tended to depart more and more completely from the mixed diet of the Pigs towards the purely herbaceous diet of the Deer and Cattle. So far, however, as we are acquainted with these intermediate animals, their general type of organisation appears to have been very like that of the Pigs. We have now, however, to consider the teeth of the modern Deer and Cattle, which we shall find to be of a still more complex type. Fig. 8 shows a somewhat worn cheek-tooth of one of the smaller Deer, which will be seen to be but a step in advance of the tooth represented in Fig. 7, the outer crescents having now become still more compressed and flattened, and both these and the inner ones having acquired a considerably greater elevation, so that the bottom of the valleys between the crescents is no longer visible. In some other species of Deer, as well as in many of the Antelopes, the crescents of the teeth become very much taller (Fig. 9), so that the intervening valleys form deep pockets, with narrow entrances, and the whole type of tooth is so utterly unlike that of the Pigs that, when the intermediate extinct types were unknown, it is small wonder that the older naturalists failed to recognise the intimate connection that really exists between the Pigs and the Ruminants, as the Deer, Cattle, &c., are often conveniently termed. Finally, in the Oxen the crowns of the teeth become still taller, with the deep valleys between the crescents more or less completely filled up with cement. In company with this remarkable modification of the cheek-teeth, the Ruminants have undergone other equally notable structural changes, some of which we may briefly mention. Thus, in the first place, all the true Ruminants have totally lost their upper incisive teeth; the lower ones, as we may all see in the Cow and the Sheep, biting against a hard pad in the upper jaw. Then, again, the two separate metacarpal and metatarsal bones found respectively in the fore and hind limbs of the Pig have fused together to form the well-known "cannon-bone," so characteristic of the limbs of the Ruminants. While, finally, in place of the simple stomach of the Pig, we find all the Ruminants furnished with that peculiarly complex type of stomach necessary for the function of "chewing the cud" or ruminating.

Fig. 8.—A Left Upper Cheek-Tooth of a Deer. Viewed from the grinding surface and from the outer side.

Fig. 9.—A Left Upper Cheek-Tooth of an Antelope. This tooth is less worn than the one in the preceding figure.

All these modifications of structure are admirably suited to the mode of life of the Ruminants. Thus the height of the crowns of the cheek-teeth, and the complex grinding surface which they present, are necessary to withstand the excessive wear to which they are subjected in the process of chewing the cud, and in thus reducing the fibres

of grass to a fine pulp. Probably also this increased height of teeth enables their owners to enjoy a longer duration of life than was possible to the Tertiary ancestors of the Ruminants. Then, again, the consolidation of the bones of the lower part of the leg into a single shaft is far better adapted to withstand the strain of supporting long-limbed and large-bodied animals when galloping at a rapid pace than would be a limb with the separate bones of the Pig. Indeed, the most specialised Ruminants, such as the beautiful Antelopes of South Africa, seem to be so admirably adapted to their mode of life that it is impossible to imagine how this type of animal life could be improved upon.

When we turn to the second great group of Ungulates, which contains the Tapirs, Rhinoceroses, and Horses, we shall find that a precisely analogous series of modifications have taken place in the structure of the teeth and feet, although they have followed a different plan. All these animals are characterised by the middle toe in each foot being symmetrical in itself; and whereas all the ancient forms, as well as the living Tapirs and Rhinoceroses, have at least three toes to each foot, the highly specialised

FIG. 10.—A LEFT UPPER CHEEK-TOOTH OF A RHINOCEROS.

Horse, as we all know, has but a single very large toe to each limb. This reduction of the number of toes and the accompanying lengthening of the whole limb, resulting in a speed which is out of all comparison with that which can be attained by the clumsy Rhinoceroses and Tapirs, and can only be equalled by that of the Antelopes and Deer.

The cheek-teeth of the Rhinoceroses and Tapirs are formed on a somewhat different plan from that obtaining in the previous group, as may be seen by comparing the figure of a Rhinoceros tooth, given in Fig. 10, with the earlier figures. The plan of structure consists, indeed, of an outer wall, with two oblique ridges or crests running towards the inner side of the crown, where they terminate in somewhat expanded pillars. When worn somewhat, the surfaces of dentine on such a tooth present the very characteristic pattern shown in the figure, which at once enables us to say to which group its owner belonged. This peculiar type of tooth can be readily derived from the four-columned tooth of the primitive Pigs (although it is not for one moment to be supposed that Rhinoceroses, &c., are descended from Pigs) by the union of the two outer cones to form the outer ridge, and also by the junction of each of the outer cones with the corresponding inner cone to make the transverse crests. The crown of the Rhinoceros's tooth, as seen from the figure, is comparatively low, and the valleys between the ridges and crests are shallow and not filled up by cement. The teeth of Tapirs are of the same general type, and so also are those of all the extinct Tertiary Ungulates of this group, from some of which, as Professors Huxley and Marsh have so clearly shown, the modern horse appears to have been evolved.

The cheek-teeth of Horses have, however, been so strangely modified from this generalised type by the great increase in the height of their crowns, and the complexity of their grinding surface, produced by foldings of the enamel of the longitudinal and transverse ridges, that it is at first sight somewhat difficult to see how the different portions of such a tooth can correspond with those of the tooth of a Rhinoceros. By the aid, however, of Fig. 11, which represents three teeth of an extinct type of Horse, we may endeavour to trace this correspondence, although the difficulty of this is unfortunately somewhat increased by Figs. 10 and 11 being taken from teeth of opposite sides of the jaw. It is, however, quite evident that the parts marked *c* and *d* in Fig. 11 correspond with the outer wall of Fig. 10; while *a* and *b* in the former represent the inner termination of the transverse crests in the latter. Further comparison of the two figures will convince us that the parts marked *e* and *f* in Fig. 11 are the equivalents of

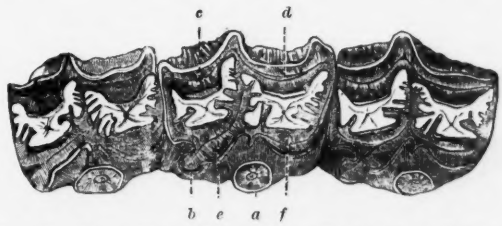

FIG. 11.—THREE RIGHT UPPER CHEEK-TEETH OF AN EXTINCT HORSE.

the middle portions of the two transverse crests in Fig. 10. Again, the white portions in Fig. 11 correspond to the terminations of the two hollows or valleys in Fig. 10, which have now become completely enclosed by the enamel, and are filled up by the white cement.

The height of the crown of one of the grinders of a Horse is, as most of us know, more than three inches; and the admirable grinding surfaces formed by alternations of three substances of different hardness, arranged in the complex manner seen in Fig. 11, is self-apparent, Horses fed on the hard substances given to them in European stables will often live to at least five-and-twenty years of age, and it is perfectly evident that this comparatively long duration of life could never be attained if these animals were not furnished with the long-crowned teeth we have just described, since the short-crowned and simple teeth of a Tapir would be entirely worn away by such a diet at a very much earlier period.

We see, then, in the Horse an animal which, in the structure of its teeth and limbs, has attained, so to speak, to the same platform of specialisation as that on which the Deer and Antelopes stand, but has reached it by a totally different ladder. It is indeed as if two different engineers had, after many intermediate steps, at last perfected two different machines, each equally well fitted for the same purpose, and each resembling one another to a certain extent in their general plan of construction, but yet differing very decidedly in details. And it cannot be too strongly im-

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pressed upon the reader what a powerful argument this gradual evolution of the teeth in two allied stocks of animals, towards the same relative perfection of structure, affords to the doctrine of a general evolution of the whole animal kingdom.

(*To be continued.*)

WHY IS SEA WATER SALT?

By W. Mattieu Williams.

THIS question must have occurred to most of us. I will endeavour to answer it; but before doing so, it is necessary that we should have the facts definitely before us.

In the first place, it is to be noted that the saltness of sea water varies considerably. The Mediterranean water contains more saline matter, bulk for bulk, than the water of the Atlantic with which it communicates. The ocean itself varies in saltness in different places, and even in different seasons at the same place in some parts.

These variations are easily explained. First, as regards the ocean, it is easy to understand that near the mouths of great rivers pouring great quantities of river water into the sea the immediate effect must be that of diminishing the salinity of the sea water there. The condition of arctic and antarctic regions of the ocean is similar, and the reason is nearly the same—the small difference being that the arctic and antarctic rivers are for the most part masses of solid water replacing the liquid streams of warmer regions.

In both cases, the water that enters the sea is the surplus rainfall from the land—its general drainage. Everybody understands this at once as regards the liquid rivers; but it may not be quite so clear to all in reference to the solid supplies, especially as the old fallacy of regarding icebergs as frozen sea water is not fully exploded.

In hot and temperate climates the rain that falls upon the land is largely utilised by vegetation, taken up from the moistened soil and exhaled as vapour from every kind of leaf and petal. Besides this, much is evaporated directly by the sun. It is only that which remains after supplying these demands that finds its way by valley channels down to the sea.

In the arctic regions very little is thus returned from the solid earth to the atmosphere, the energies of both vegetable exhalation and solar evaporation operate there but feebly. The downfall, however, is great, due to the winter condensation of the vapour in the upper currents that flow polewards from all sides. It falls chiefly as snow, which, by its accumulation, would top the clouds unless it could somehow travel downwards. It does thus travel downwards by the same courses as the liquid rivers of warmer regions, *i.e.* by the valleys—first, by the upper valleys, which pour their tributary streams of ice into the lower and greater valleys, along which the confluent mass flows down till it reaches the sea. There it crawls along the ocean bed until its depth is so great that its power of flotation breaks it by bending upwards to separate in iceberg masses, an operation which our sailors describe as calving.

Our knowledge of this motion is primarily derived by studying the phenomena of the overflow of the snow that falls on the upper regions of the Alps and other mountains more easily within reach than those around the poles of the earth. The rate of flow of these ice rivers, or glaciers, has been accurately measured, and such flow has been proved to obey the general laws of the flow of liquid rivers. Its rapidity increases with the angle of downward inclination of the bed of the valley on which it rests; it is more rapid in the middle than at the sides, and in other respects the ice behaves as a viscous fluid, but one of vastly greater tenacity than unfrozen water.

As this fluidity of ice has been somewhat disputed, I may describe an experiment of my own which, I think, demonstrates it. I have had constructed a screw squirt, of about the same dimensions as one of those that give joy to mischievous boys, but instead of being made of pewter its body is a strong iron tube, and its taper nozzle of brass; into the body is accurately fitted an iron plug, or piston. This is driven forward by a screw attached to a cross-handle. I charge this with fragments of ice, the bore being about $\frac{1}{2}$ inch in diameter, and on forcibly driving down the piston the ice is squirted in a solid stick or stream about $\frac{1}{15}$ of an inch in diameter, *i.e.* of the same size as the ordinary middle-sized "leads" of an ever-pointed pencil. If I put in, say 20 $\frac{1}{2}$-inch lumps of ice, I get by rapid squirting 20 long sticks, or by slow squirting one continuous stick. In the second case, there is time for the complete welding of all the pieces into one; in the first, this occurs but imperfectly.

Alpine travellers who study glaciers are familiar with the fact that a great stream of ice flowing down a wide valley alters its shape when it encounters a narrow gorge, passes through this, and then spreads out again if the valley widens below. If a narrow ice-filled valley terminates in a plain, but slightly inclined, the ice-torrent spreads out, and forms a lake of ice if the plain is a table-land of sufficient elevation, or a fan-shaped terminal outspread, if lower down. The Aletsch glacier in Switzerland, and the Justedal in Norway are examples of the first case; the Rhone glacier of the Alps, and the Nygaard glacier in Norway are examples of the latter. We may even find limited examples of ice cataracts where a glacier in its downward course reaches the edge of a precipice, bends over and reaches down a certain distance, then breaks off and leaves an ice cornice, which advances, bends downwards, and breaks again.

I have described a remarkable example of this in my *Through Norway with a Knapsack*. The cascade pours over from the great ice-lake of the Justedal—500 square miles in area—into the desolate and dreary Styggevand, where the icebergs formed by such fracture are floating.

I am dwelling thus on this part of the subject because the magnitude of this influence on the distribution of ocean salinity does not appear to have been fairly appreciated. The dimensions of the arctic and antarctic glaciers are so vast, that those of the Alps which so greatly astonish the tourist become mere dribbles by comparison. Sir J. C. Ross sailed along the terminal face of one for a distance of 450 miles—this representing merely its breadth. This great terminal ice cliff rose from the water to a height of 180 feet in some places (it must have been four or five times deeper below the surface), and it was not throughout all this distance broken by a single inlet. Only at one point could the surface of the ice be seen from the mast-head. Here it was 50 feet thick, and looking over this was seen a smooth plain, like frosted silver, stretching away to "illimitable distances."

Those who have experienced the sultry heat of arctic summer time when the sky is clear (I have seen the thermometer standing at 92° Fahr. in a little deck cabin, and 108° in the sun between 70° and 71° N. latitude), can appreciate the amount of thawing and consequent freshwater supply that must occur by the combined action of this heat and the salt of the sea water, an action which is greatly masked by the fact that salt and brackish water

does not re-expand when cooled below 39° Fahr., but goes on increasing in specific gravity to between six and seven degrees below the freezing point of pure water.

A result of this is that there must be a continuous undercurrent of brackish water flowing from the polar regions of the ocean towards the tropics. This, I suspect, is the reason why, nearly all the world over, the lower depths of ocean are occupied by water having a temperature which does outrage to ordinary theory, by being so far below the mean of the solid surface, and indicating no reception of heat from the supposed cooling down of the earth. Instead of this, "the average temperature of the bottom of the deep sea in temperate and tropical regions is about the freezing point of fresh water" (Dr. C. Wyville Thomson). This, however, is only the case where there is free communication with the circumpolar waters.

In the next and concluding portion of this paper will be demonstrated the apparent paradox that the river flows which are reducing the immediate salinity of the oceans are at the same time the main, if not the sole, sources from which this salinity has been derived, and which salinity they are, probably, still increasing.

THE FACE OF THE SKY FOR JULY.

By HERBERT SADLER, F.R.A.S.

UNTIL after the first three weeks of the month there will be no real night throughout the British Islands, but either daylight or twilight. During the past month the disc of the sun has been almost entirely clear of spots. Conveniently observable minima of Algol take place at 0h. 20m. A.M. on the 15th, and 9h. 9m. P.M. on the 18th. Mercury is a morning star during the first portion of the month, but is not well situated for observation in July. On the 1st he rises at 2h. 40m. A.M. in bright twilight, with an apparent diameter of $6\frac{1}{2}''$, and a northern declination of 21° 19′. On the 10th he rises at 2h. 50m A.M. with an apparent diameter of $5\frac{1}{2}''$, and a northern declination of $23\frac{1}{2}°$. He comes into superior conjunction with the sun at 10h. P.M. on the 22nd. While visible, the planet passes from Taurus into Gemini, but does not make a very close approach to any bright star. Venus is an evening star, and is a conspicuous object in the N.W. horizon after sunset. She sets on the 1st at 10h. 10m. P.M., with an apparent diameter of 13″, and a northern declination of $18\frac{1}{2}°$. On the last day of the month she sets at 9h. 11m. P.M., with an apparent diameter of 15″ and a northern declination of $5\frac{1}{2}°$. At 5h. P.M. on the 17th she is in conjunction with Saturn, Venus being 6′ to the south; the conjunction, of course, occurs in broad daylight, but both planets will appear very near together after sunset. During the month she passes from Cancer into Leo. During the second week in July, Venus, Saturn, and Regulus will present remarkable and varying triangular conformations near the W.N.W. horizon. Venus is now decidedly gibbous, only about $\frac{3}{4}$ of the disc being illuminated at the end of the month. Mars is an evening star, though, owing to his great southern declination, he is very unfavourably situated for observation in these latitudes. He rises on the 1st at 5h. 3m. P.M., with a southern declination of 22° 41′ and an apparent diameter of $17\frac{1}{2}''$. On the 31st he rises at 3h. 30m. P.M. and sets at 11h. 12m. P.M., with an apparent diameter of 14·0″ and a southern declination of 23° 50′. On the latter date his brightness is only about half what it was at opposition. His disc appears markedly gibbous in a large telescope, nearly one-eighth of the disc being obscured at the end of the month. He is apparently stationary on the 4th. He oscillates between Scorpio and Libra, without approaching any bright star very closely. Jupiter is an evening star, and rises on the 1st at 9h. 46m. P.M., with an apparent equatorial diameter of $46\frac{1}{2}''$ and a southern declination of $18\frac{1}{4}°$. On the 31st he rises at 7h. 40m. P.M., eight minutes before sunset, having an apparent equatorial diameter of 48″ and a southern declination of $19\frac{1}{4}°$. He is in opposition on July 30th at noon, when his distance from the earth is about $378\frac{1}{4}$ millions of miles. The following phenomena of the satellites occur while the planet is more than 8° above and the sun 8° below the horizon. A transit egress of the shadow of the first satellite at 11h. 25m. P.M. on the 3rd, and an eclipse disappearance of the second satellite at 11h. 39m. 34s. the same night. An egress from transit of the first satellite at 0h. 4m. A.M. on the 4th. An egress from transit of the shadow of the third satellite at 10h. 45m. P.M. on the 7th, and an egress of the satellite itself at 1h. 2m. A.M. on the 8th. This and other transits of satellites iii. and iv. should be carefully watched, as they may appear as dark spots on the planet's disc. An eclipse disappearance of the first satellite at 1h. 49m. 30s. A.M. on the 10th; a transit ingress of the shadow of the first satellite at 10h. 59m. P.M. the same day, and a transit ingress of the satellite itself at 11h. 28m. P.M. On the 11th a transit egress of the shadow of the first satellite at 1h. 19m. A.M., and a transit egress of the satellite itself at 1h. 48m. A.M.; an eclipse disappearance of the second satellite at 2h. 13m. 53s. A.M.; a transit ingress of the fourth satellite at 10h. 56m. P.M., and an egress of its shadow at 11h. 26m. P.M.; a reappearance from occultation of the first satellite at 11m. 4m. P.M. A transit egress of the shadow of the second satellite at 11h. 59m. P.M. on the 12th. A transit egress of the second satellite at 0h. 52m. A.M. on the 13th. A transit ingress of the shadow of the third satellite at 11h. 7m. P.M. on the 14th. A transit ingress of the shadow of the third satellite at 0h. 39m. A.M. on the 15th; and a transit egress of the satellite's shadow at 2h. 46m. A.M. An ingress of the shadow of the first satellite at 0h. 53m. A.M. on the 18th; a transit ingress of the satellite itself at 1h. 11m. A.M.; an eclipse disappearance of the first satellite at 10h. 12m. 37s. P.M. On the 19th a reappearance from occultation of the first satellite at 0h. 48m. A.M., a transit egress of the shadow of the first satellite at 9h. 41m. P.M.; a transit egress of the satellite itself at 9h. 57m. P.M.; an ingress of the shadow of the second satellite at 11h. 43m. P.M. A transit ingress of the second satellite at 0h. 14m. A.M. on the 20th, and a transit egress of the shadow of this satellite at 2h. 36m. A.M. On the 25th a transit ingress of the shadow of the first satellite at 2h. 47m. A.M., and a transit ingress of the shadow of the satellite itself eight minutes later; a reappearance from occultation of the third satellite at 9h. 20m. P.M. On the 26th an eclipse disappearance of the first satellite at 0h. 7m. 17s. A.M.; a reappearance from occultation of the same satellite at 2h. 32m. A.M.; a transit ingress of the shadow of the first satellite at 9h. 15m. P.M., and a transit ingress of the satellite itself six minutes later; a transit egress of the shadow of the first satellite at 11h. 35m. P.M., and a transit egress of the satellite itself six minutes later. This transit should be carefully watched, as the satellite may be projected on its shadow. This will be a very good opportunity for observing whether the shadow is larger than it ought to be, as has been stated by some observers. (*See* Webb's *Celestial Objects*.) A transit ingress of the shadow of the second satellite at 2h. 20m. A.M. on the 26th, and a transit ingress of the satellite itself ten minutes later. A reappearance from occultation of the second satellite at 11h. 37m. P.M. on the

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28th. Jupiter describes a short retrograde path in Capricornus, and on the evening of the 11th he will be about $6\frac{1}{2}'$ north of the 6th magnitude star 19 Capricorni, but he does not approach any other naked-eye star. Saturn is just visible over the W.N.W. horizon after sunset; setting on the 1st at 10h. 44m. P.M., with a northern declination of 12° 51′ and an apparent diameter of $16\frac{1}{2}''$, but it would be useless to give any details of the phenomena of the satellites, &c. On the 30th he sets at 8h. 51m. P.M., with a northern declination of 11° 40′, and an apparent diameter of $15\frac{3}{4}''$. We have alluded above to his conjunction with Venus on the 17th. He describes a short path in Leo to the east of Regulus. Uranus is an evening star, rising on the 1st at 1h. 20m. P.M. with a southern declination of $8\frac{1}{4}°$ and an apparent diameter of $3\frac{1}{2}''$. On the 31st he sets at 10h. 9m. P.M. with a southern declination of 8° 25′. He describes a short retrograde path in Virgo in a region barren of naked-eye stars. Neptune is invisible. Shooting stars are fairly numerous in July, though the twilight interferes with observation. A well-marked shower radiates from near δ Aquarii; the maximum being on the 28th. The radiant point is in 22h. 40m.—13°. The moon is full at 2h. 23m. P.M. on the 2nd; enters her last quarter at 4h. 43m. A.M. on the 9th; is new at 0h. 50m. A.M. on the 17th; enters her first quarter at 2h. 44m. A.M. on the 25th; and is full at 9h. 24m. P.M. on the 31st. At 9h. 14m. P.M. on the 2nd the $5\frac{1}{2}$ magnitude star ψ Sagittarii will disappear at an angle of 54° from the lunar vertex, and reappear at 10h. 21m. P.M. at an angle of 253° from the vertex. At 1h. 52m. A.M. on the 5th the 6th magnitude star 37 Capricorni will disappear at an angle of 63° from the vertex, and reappear at an angle of 333° from the vertex at 2h. 46m. A.M. On the same morning the $4\frac{1}{2}$ magnitude star ε Capricorni will disappear at 3h. 25m. at an angle of 165° from the vertex, and reappear at 4h. 15m. A.M. (23 minutes after sunrise) at an angle of 263° from the vertex. At 1h. 7m. A.M. on the 13th the $3\frac{1}{2}$ magnitude star ε Tauri will disappear at an angle of 24° from the vertex, the star being on the horizon at the time, and reappear at 1h. 41m. A.M. at an angle of 301° from the vertex.

Whist Column.

By W. MONTAGU GATTIE.

THE DISCARD—PLAYING TO THE SCORE.

THE following is an elementary explanation of the play of the hand published in the June number of KNOWLEDGE:—

Trick 1.—A leads from his longest plain suit. The student will observe that A B only require the odd trick to win the game, so that it is not necessary to play for making a great number of tricks. A therefore does not open trumps immediately, although he holds five to the queen. Y plays the ten of spades, retaining the command of the adverse suit. It would be very bad play to put on the ace in order to lead trumps. B plays the lowest of his sequence, and Z, of course, plays his lowest card. A having declared spades as his suit, B infers that he has at least four of them. It is worth noticing, also, although it does not affect the subsequent play, that A can place either ace, queen, or king, queen, of spades in B's hand. For the honours in the suit (unless B has them all) are clearly divided between B and Y; neither of them can hold ace, king, or they would have played king; and Y, from king, queen, or from ace, queen, ten, would have played queen.

Trick 2.—B opens his long suit on the American system of leading the fourth-best; Z plays his lowest and A his best diamond, and Y wins with the lowest card he can. B infers that Z has no smaller diamond than the seven, and that A has none higher than the eight (for B himself holds the nine, and A would be bound to play any higher card if he had it). The deuce may be with either A or Y; the ten must be with Z; and the ace and queen lie between Y and Z.

Trick 3.—Y naturally opens trumps, and leads the deuce because he knows his partner holds the ace (the turn-up card), and the eight (the fourth-best) is too good a card to be thrown away for the sake of showing number.

Trick 4.—Z's failure to return his partner's lead of trumps shows everyone at the table that he has no more. In default, he opens his strong suit by leading the fourth-best. A plays his lowest and Y his best heart, and B infers that A has no smaller heart than the eight. A would play very badly in putting in his king, as some players are fond of doing second in hand when they only hold one other card of the suit. He would not only be exposing his own weakness and assisting the adversaries to establish the hearts, but he would be giving up a possible card of re-entry, which, in the present instance, proves essential to save the game.

Trick 5.—B hopes to find his partner void of diamonds, the deuce being the only one he can possibly hold. Otherwise the king of spades would be a better lead, there being very little hope of establishing the diamonds. Under ordinary circumstances, as B is weak in trumps, he should not force his partner; but, with an adverse trump lead and the score at 4, it is the right play. Z properly holds up the ace, as he knows from trick 2 that A cannot beat the ten.

Trick 6.—Y, of course, goes on with the trumps, especially as he can draw two to one. B's card shows Y that the small trumps are with A; but the position of the queen is doubtful. Z discards from his weak spades.

Trick 7.—Y continues the trumps, hoping that B may have the queen, in which case Y's two remaining trumps and the ace of spades would win the game. A's winning with the queen shows B that he has not the knave, and therefore that Y Z are "two by honours." Y must also hold the ten of trumps.

Trick 8.—A can do no better than go on with his spades, especially as he knows from trick 1 that his partner holds two honours in the suit.

Tricks 9 *and* 10.—With the assistance of the foregoing remarks, the student will, we think, have no difficulty in understanding the explanation given in our last article of B's discards to these two tricks. It must be borne in mind that his play is only justified by the state of the score, which requires that A B should make every trick after the trumps are exhausted. Otherwise B would have no right to throw away two certain tricks on the chance of making three.

AMERICAN WHIST.*

Under this title a new book on whist has recently been published, and has already reached its third edition. It is, as stated in the preface, a digest of two treatises, called *American Whist* and *Whist Universal*, both of which are well known in America, together with "all the amendments, revisions, and changes in play required by the application of recent inventions and improvements in the practice of the American game." As a text-book of the game, as played at the Deschapelles Club of Boston, it will

* *American Whist Illustrated.* By G. W P. Longmans, Green and Co. London: 1890.

be found both convenient and complete; and, although its value to English players is, of course, affected by the differences between the laws there adopted and the code universally recognised in this country, it contains much sound practical advice and several interesting suggestions of general application. We only regret that the tone of the book should, here and there, be marred by somewhat invidious comparisons between the American and English games, the conclusions drawn being, it is scarcely necessary to say, invariably in favour of the "new play."

We cannot but think that, in a work intended for publication in England, it would have been more courteous to refrain from slighting references to a code of laws drawn up by some of the finest English players, and from attributing to prejudice or want of intelligence the objections which many competent authorities entertain to certain innovations. Such remarks as "They call this playing whist in London" should certainly find no place in a treatise that aspires to be considered serious. So much as to the matter of taste, independently of the merits of the various questions at issue. Whether the American doctrines of "lead and follow" and of the "plain-suit echo" should be accepted; whether the lowest but two of a six-card suit should be called the fourth-best or the antepenultimate; whether the lead of nine from king, knave, nine, and others is right, while the lead of the same card from ace, queen, nine, and others is wrong; whether ace should be led from a four-card suit of which the lowest is the deuce, and whether the lead of a deuce is consequently proof positive that the leader has not the ace; whether king or knave is the proper card to lead from a quart major in a plain suit, and whether or not ace should be led before king from a five-card suit—all these and many kindred questions must be determined by advanced players for themselves. We have, however, no hesitation in asserting that the beginner who endeavours to master the mysteries, or, as some say, the simplicity of the "new play," will, unless he be possessed of phenomenal capacity for the game, find himself very shortly in hopeless confusion.

The distinctive laws of the new American game may be of interest to our readers. A game consists of seven points, or as many more as may be made by the hand in which seven is reached. As in England, each trick made beyond six counts one point; but nothing is scored for "honours." The cards are played for all the points that can be made. No additional points are scored for the "rubber." The following is a specimen of a score-card for one rubber:—

	Names.	Points of Game 1.	Points of Game 2.	Points of Game 3.	Rubbers.	Games.	Points.
Partners.	A	2106	1100	403	1	2	18
	B	2106	1100	403	1	2	18
Partners.	C	0040	0062	020	0	1	14
	D	0040	0062	020	0	1	14

Here A and B win four points each on the rubber, and C and D lose the same number.

Every hand must be played out. If cards are thrown down, the game is scored by the adversaries, who take a point for each card in any one hand so abandoned. The penalty for a revoke is the same as in England; for any other offence against rule, such as playing two cards at once, exposing a card, playing out of turn, &c., the penalty is the loss of a point by the offender, or the addition of a point to the claimant's score; but how matters are decided, if, in consequence of this law, a player arrives at the score of seven sooner than his partner, the code does not explain.* The score of the game must be called and counted before the cards for the next deal are cut. If a card is exposed while dealing, the deal is lost. We are disposed to think that the introduction into the English code of some regulation calculated to prevent players from prematurely abandoning their hands is worth consideration. The process of calling cards that have been hurriedly cast down under some misapprehension is always unpleasant and unsatisfactory to all parties.

The book concludes with a series of illustrated hands, as to which we shall probably have something further to say next month.

Chess Column.

By I. GUNSBERG (MEPHISTO).

[Contributions of general interest to chess-players are invited. Mr. Gunsberg will be pleased to give his opinion on any matter submitted for his decision.]

PROBLEMS BY J. H. BLACKBURNE.

(*Published June* 1890.)

WE regret that owing to a printers' error a black Rook has been placed on White's KKt3 instead of a white one. We therefore give the positions again.

White—K on KR3, R's on KKt1 and QKt3, B's on Q2 and QKt5, Kt on KB8, P's on KR6, KB3, KB4, QB5 (10 pieces).

Black—K on KB4, Kt's on K4 and QR5, P's on KR2 and KB3 (5 pieces), three moves.

SOLUTION.

1. R—QR1	1. Kt×P (best)
2. R—R5	any
3. B mates	

No. 2.

White—K on KR6, Q on QB7, R on K5, B on QR5, Kt on Q6, P's on KR2, K2, QB6, QKt4 (9 pieces).

Black—K on Q5, P on K3 (2 pieces), three moves.

SOLUTION.

1. Q—KR7	1. K—B6 or K×R
2. Q—Kt1, K—Q7 or Q5	2. Q—R7, K×Kt, K—B4, B6
3. P—Kt5 or Q—Kt2 mate	3. Q—B5, Q4 or Kt7, mate

Both these problems embody highly original notions, and have no doubt served as models for many subsequent problems.

A VERY SUCCESSFUL GAME RECENTLY PLAYED AT SIMPSON'S DIVAN.

SCOTCH GAMBIT.

WHITE. REV. W. GRUNDY.	BLACK. D. C. MULLER.
1. P—K4	1. P—K4
2. Kt—KB3	2. Kt—QB3
3. P—Q4	3. P×P
4. Kt×P	4. B—B4
5. B—K3	5. Q—B3
6. P—QB3	6. KKt—K2
7. Kt—B2	

White induces Black to exchange Bishops, in order to post his Knight on K3, which is a doubtful advantage. If Black declines to exchange by playing B—Kt3, White plays 8. QKt—R3, threatening 9. Kt—Kt5, &c., which Black cannot conveniently prevent by P—QR3, as White could then play 10. B×B, doubling the Pawns.

7. P—Q3

Instead of this move the following continuation is given in Steinitz's book—7. B×B; 8. Kt×B, Q—Q4. (9. Kt—Q2 or B—Q3. P—Q4, with an even game.) 9. Q—B3, castles; 10. Kt—B4, Q—KKt4; 11. QKt—Q2, P—Q3, &c.

8. B×B	8. P×B

* We believe that in practice the offender and his partner both suffer the penalty; but this is not what the law says. The whist-players of Boston, we are told, prefer a "simple and intelligible" code to "the voluminous one that regulates the English play." It seems to us that the law in question fulfils neither condition.

XUM

The immediate exchange of Bishops does not seem to operate in White's favour.

9. B—Q3

B—K2 was safer play, as Black can harass the Bishop by playing Kt—K4.

	9. Castles
10. Kt—K3	10. R—Qsq

Although the principles of development say that KR should not be moved to a square which can conveniently be occupied by the QR, yet Black has good reason for playing R—Qsq, as he thereby gains important time, compelling White to move his Queen, and retire his Bishop subsequently, while developing his own forces.

11. Q—B2	11. Kt—K4
12. B—K2	12. B—K3
13. Castles	13. Kt (K2)—Kt3

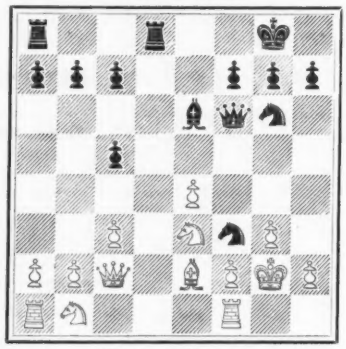
White would hardly be able to survive the effects of Kt—B5.

14. P—KKt3	14. Kt—B6 (ch)
15. K—Kt2	

B×Kt was a safe reply, to be followed by Kt—Q2, &c. The move in the text enables Black to finish the game by an ingenious and masterly combination, winning the game in five moves.

POSITION AFTER WHITE'S 15TH MOVE, K—Kt 2.

BLACK, 14 PIECES.



WHITE, 14 PIECES.

15. B—R6 (ch)!

16. K×B

Of course if 16. K—Rsq, B×R with advantage.

	16. Kt—B5 (ch)!!
17. P×Kt	17. Q—R5 (ch)
18. K—Kt2	18. Q×P (ch)
19. K×Kt	19. Q—R6 mate

We do not recollect ever having seen a mate given by the Queen alone in this fashion, the hostile King being surrounded by all his own pieces. It is indeed a clean finish.

GUNSBERG v. TSCHIGORIN.

Twenty-third and last game played in the Havana match:—

CENTRE GAMBIT.

BLACK. Tschigorin.	WHITE. Gunsberg.	BLACK. Tschigorin.	WHITE. Gunsberg.
1. P to K4	P to K4	23. KR to Ksq	R to R2 (*k*)
2. P to Q4	P takes P	24. R to K2	Kt to Q2 (*l*)
3. Q takes P	Kt to QB3	25. P to B3	P takes P
4. Q to K3 (*a*)	Kt to B3 (*b*)	26. Kt takes P	R to K3 (*m*)
5. Kt to QB3 (*c*)	B to Kt5	27. R to QB2	Kt to Kt3 (*n*)
6. B to Q2	Castles	28. B to B2	B takes B
7. Castles	R to Ksq (*d*)	29. R takes B	Kt to B 5
8. P to B3 (*e*)	P to Q4	30. Q to Q8 (*o*)	R to Ksq
9. B to Ksq	P to Q5	31. Q to Q4	QR to Rsq
10. Q to B2	Q to K2	32. R to B2	KR to Qsq
11. Kt to Kt sq (*f*)	B to QB4	33. Q to B2	R takes R ch
12. B to Q3	B to K3	34. Kt takes R	Q to Q3
13. P to QR3	Kt to K4	35. Q to Kt3	Q to Q6
14. Q to Bsq	P to B3 (*g*)	36. Q to Ksq	R to Qsq (*p*)
15. Kt to R3	Kt takes B	37. R to B3	Q to Q3
16. Q takes Kt	P to QKt4	38. P to R3	P to R3 (*q*)
17. Kt to B4	B to B5	39. Kt to B2 (*r*)	Q to Kt6
18. Q to Q2	P to QR4	40. Q to Ktsq	Q to Kt4 ch (*s*)
19. B to R4	Q to Q3	41. K to Kt sq	R to Q7
20. B to Kt3	Q to Bsq (*h*)	42. Kt to Q3 (*t*)	Q to Qsq (*v*)
21. Kt to Q3	B takes Kt (*i*)	43. Kt to Kt4	R to Q8 ch
22. Q takes B	P to R5	Resigns	

NOTES.

(*a*) At the Bradford tournament of 1881 Hall placed 4. Q to B4, to which move Mortimer replied with a counter gambit, playing for Black P to QKt4.

(*b*) When Mr. Paulsen first brought this move into prominent notice it was thought that Black could not play Kt to B3 on account of White gaining time by playing 5. P to K5. Professor Berger, however, discovered a good reply, which is as follows:—

5. P to K5	5. Kt to K Kt5
6. Q to K4	6. P to Q4!
7. P takes P *en pass* ch	7. B to K3
8. P takes P	8. Q to Q8 ch
9. K takes Q	9. Kt takes P ch, &c with the better position.

If in this variation White plays 6. Q to Q2, Black must reply with P to Q3. The result of White not being able to play P to K5 is that Black develops his pieces quickly, with which he will harass the White Queen.

(*c*) B to K2 is White's best move.

(*d*) Gives Black a pull at once.

(*e*) A better provision against Black's next move of P to Q4 than B to Q3.

(*f*) White is driven back all along the line. Black might now also have continued with B takes B followed by Kt to Kt5, but from this manœuvre no definite result is discernible.

(*g*) This seems too slow. P to QKt4 was perhaps feasible.

(*h*) Black's chance of assault depends on his being able to keep the White QRP twice attacked.

(*i*) If the Black KB retires, White plays Kt to Kt5.

(*k*) To make the Rook available on Kt2 as well as Q2, if necessary, but P to Kt5 was perhaps more vigorous.

(*l*) Black's intention is to take possession of the important point on QB5 with his Knight.

(*m*) To prevent White from forcing an exchange of pieces by B to Q6.

(*n*) White sees that if he allows Black to play Kt to B5, the latter may then sacrifice a piece.

(*o*) White was playing under time pressure.

(*p*) Black has now obtained the position he was playing for. It is doubtful, however, whether he has sufficient advantage to win.

(*q*) Black has allowed many opportunities to slip by through somewhat timid play. Kt to K4 seems more promising, to be followed up by an advance on the Queen's side.

(*r*) This move loses the game. Kt to K3 was better.

(*s*) Stronger than R to Q7 at once.

(*t*) Kt to Qsq was the only move to keep the game a few moves longer.

(*v*) Black makes up for lost time. If White plays 43. Q to KBsq, R takes P ch follows.

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